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FEASIBILITY REPORT FOR FLOOD CONTROL MAIN REPORT(U)
CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 82

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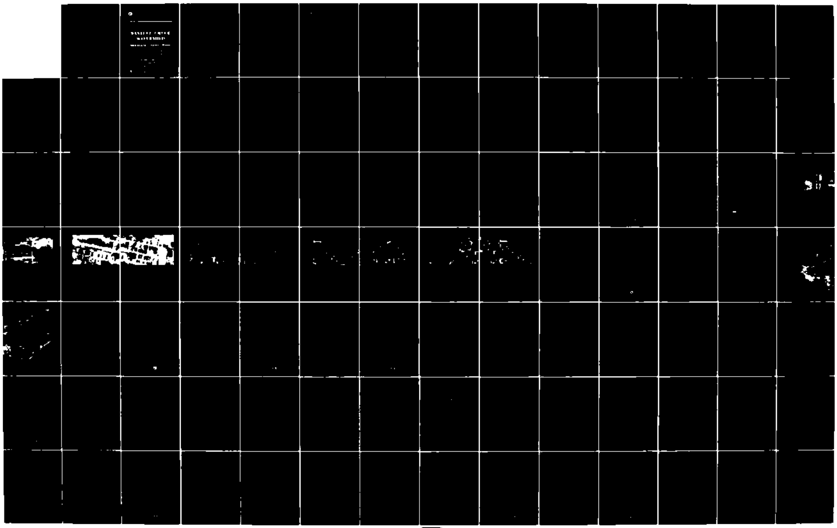

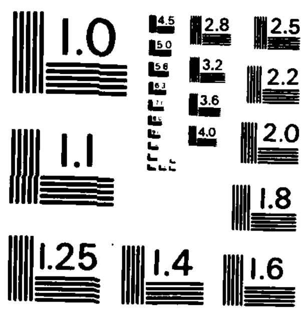

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US Army Corps
of Engineers
St. Paul District

SEPTEMBER 1982

AD-A133 295

Flood Control

BASSETT CREEK WATERSHED

Hennepin County, Minn.

Design Memorandum No. 2
Phase II
General Project Design
and
Environmental Assessment

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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See AD-A119 394/5 for appendices.

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MINNESOTA

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Bassett Creek watershed is located within the Minneapolis-St. Paul metropolitan area and entirely within Hennepin county. Potential for flooding is expected to increase with urbanization of the watershed. The sstudy reviews the water and related land resource problems and potential solutions to these problems.

The main report is a general nontechnical presentation of the feasibility study of water and related land resources in the Bassett Creek watershed.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

This basic document presents a broad view of the overall study and is intended for the general reviewer. Included in the main report are plan formulation and selection procedures, division of project responsibilities between Federal and non-federal interests and recommendations for implementing the selected plan.

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT. CORPS OF ENGINEERS
1135 U S POST OFFICE & CUSTOM HOUSE
ST PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF: NCSED-M

30 September 1982

SUBJECT: Flood Control, Bassett Creek Watershed, Hennepin County, Minnesota, Design Memorandum No. 2, Phase II, General Project Design

Commander, North Central Division
ATTN: NCDED-T

1. The subject design memorandum presents designs and discussions of engineering studies and the environmental assessment for flood control improvements in the Bassett Creek Watershed and is submitted in accordance with ER 1110-2-1150.

2. By NCSED-PB letter dated 30 August 1979, subject: Bassett Creek Watershed, Hennepin County, Minnesota, Phase I GDM, Study Classification, the St. Paul District recommended deletion of the Phase I GDM and initiation of Phase II GDM studies. This recommendation was approved by 1st Indorsement, NCDED-T, 4 September 1979. Design Memorandum No. 1, Hydrology and Hydraulics, presented hydrology and hydraulics design information normally presented in a Phase I GDM study.

3. I have met with local officials of the cities of Minneapolis and Golden Valley and with representatives of the Bassett Creek Flood Control Commission to discuss project sponsorship. The city of Minneapolis understands and fully supports this project and has indicated an interest to discuss innovative project financing proposed by the current Administration.

Edward G. Rapp

EDWARD G. RAPP
Colonel, Corps of Engineers
Commanding

DEPARTMENT OF THE ARMY
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

AND

ENVIRONMENTAL ASSESSMENT

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Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL
BASSETT CREEK WATERSHED
HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2

PHASE II
GENERAL PROJECT DESIGN
AND
ENVIRONMENTAL ASSESSMENT

Design Memorandum Index

D.M. No.	Item	Scheduled Completion	Submittal NCD	Submittal OCE	Approved
1	Hydrology & Hydraulics	Jul 81	May 81	Jul 81	Aug 81
2	Phase II - General Project Design	Aug 82	Sep 82		
3	Tunnel Feature Design	Oct 83			
	Environmental Assessment and FONSI		Sep 82		

Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL
BASSETT CREEK WATERSHED
HENNEPIN COUNTY, MINNESOTA

GENERAL DESIGN MEMORANDUM
PHASE II

Pertinent Data

Project Document - House Document No. 95-360, 95th Congress, 2d Session.

Project Authorization - 1976 Water Resources Development Act (Public Law 94-587).

Project Purpose - Flood Control.

Location - The project is located in Hennepin County and Minneapolis, Minnesota, on Bassett Creek, a tributary of the Mississippi River.

Hydrology and Hydraulics

Watershed drainage area	43 sq. miles
Design flood frequency	Once in 100 years
Design flood flow (tunnel)	660 cfs

Principal Items of Work

Tunnel, 10' Diameter Equivalent	6,600 L.F.
Tunnel, 12' Diameter Equivalent	4,800 L.F.
Flood Control Structures	7
Earth Embankments for Control Structures	5
Bridge Removals	2
Railroad Bridge Replacement	1
Railroad Bridge Modification	1
Low Hea^ am Removal & Replacement	1

Culvert Replacements	9
Culvert Removal	1
Floodproofing Residential Structures	24
Channel Improvement & Bank Protection	2,085 L.F.
Bank Protection	2,085 L.F.
Storage Area Excavation (2 areas)	282,000 cy

<u>Economics</u>

Federal First Cost	$22,300,000
Non-Federal First Cost	6,240,000
Total First Cost	28,540,000
Average Annual Operation & Maintenance Cost	17,500
Total Average Annual Cost	2,329,200
Average Annual Benefits	2,802,100
Benefit-Cost Ratio	1.20
Benefit-Cost Ratio including Area Redevelopment Benefits	1.31

AUTHORIZATION

1. The authority for this project is contained in Section 173 of the 1976 Water Resources Development Act (Public Law 94-587) which states:

> "The project for flood protection in the Bassett Creek Watershed, Minnesota, is hereby adopted and authorized to be prosecuted by the Secretary of the Army, acting through the Chief of Engineers, substantially in accordance with the plans and subject to the conditions contained in the report of the Board of Engineers for Rivers and Harbors dated July 26, 1976, at an estimated cost of $7,953,000. This shall take effect upon submittal to the Secretary of the Army by the Chief of Engineers and notification to Congress of the approval of the Chief of Engineers."

2. Submittal of the favorable report of the Board of Engineers for Rivers and Harbors to the Secretary of the Army occurred on 30 March 1977. Notification to Congress of the approval of the Chief of Engineers occurred in a letter from the Secretary of the Army dated 19 June 1978.

LOCAL COOPERATION

3. The local project sponsor is the city of Minneapolis, Minnesota. By resolution dated 11 December 1981, the city of Minneapolis has indicated its support for the project and willingness to provide the required items of local cooperation. The items of local cooperation include:

a. Provide without cost to the United States all lands, easements, and rights-of-way, including borrow areas and disposal areas for excavated material determined suitable by the Chief of Engineers and necessary for construction of the project;

b. Hold and save the United States free from damages that may result from construction of the project, not including damages due to the fault or negligence of the United States or its contractors;

c. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army;

d. Share in the cost of the nonstructural portion of the project in accordance with cost-sharing provisions being developed under Section 80 of Public Law 93-251;

e. Accomplish without cost to the United States all relocations and alterations of buildings, transportation facilities, storm and sanitary sewer systems, public and private utilities, local betterments, drainage facilities, and other structures and improvements made necessary by construction of the recommended plan, excluding railroad bridges and approaches and facilities necessary for the normal interception and disposal of local interior drainage at the line of protection;

f. Prescribe and enforce regulations to prevent obstruction or encroachment on channels and temporary storage areas which would reduce their flood-carrying or storage capacity or hinder maintenance and operation;

g. Provide a cash contribution for recreation equal to 50 percent of the final separable cost allocated to this function less a credit for the value of lands, easements, rights-of-way, alterations, and relocations allocated therefor;

h. Publicize flood plain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to insure compatibility between future development and protection levels provided by the project; and

i. At least annually inform affected interests regarding the limitations of the protection afforded by the project.

4. Sponsoring communities within the watershed have a long history of providing leadership in preventing unwise future development in floodplain areas. Most communities in the watershed had established floodplain development policies well before the Federal Insurance Administration's floodplain management requirements were completed. The Bassett Creek Flood Control Commission was established in 1969 under a joint powers agreement to provide leadership in floodplain management for the nine watershed communities. The Commission immediately acquired the services of a water resources consulting engineering firm to provide the technical expertise required in providing wise management leadership. Periodically, the Commission distributes newsletters to keep area residences and businesses informed on floodplain development issues and of progress on the flood control project. An appraisal report prepared in August 1982 for the city of Golden Valley reveals that over 470 acres of floodplain properties in five communities have been acquired at a cost of $3,970,000 to prevent floodplain development. Although the properties have been turned into recreational areas the intent in acquisition was to prevent floodplain development.

5. Since adoption of the Commission's overall plan in 1972, no development has occurred along the main stem or tributaries which would be damaged by the project's design event. The Commission has had review authority (individual communities have enforced the Commission's recommendations) on any development in or near a management envelope which includes from 1 to 3 feet of freeboard over the 100-year flood as determined in 1972.

6. On 23 July 1982, the St. Paul District Engineer met with Mayor Donald Fraser, city of Minneapolis, and other elected and staff officials of the city of Minneapolis, the city of Golden Valley and with representatives of the Bassett Creek Flood Control Commission to reaffirm the sponsoring agency's understanding and support for the project and interest in providing the required items of local cooperation under the cost-sharing policies now being developed. The city of Minneapolis has indicated that it fully understands and supports the project and by letter dated 17 August 1972, has indicated an interest to discuss innovative project financing as proposed by the current Administration.

LOCATION OF PROJECT AND TRIBUTARY AREA

7. The Bassett Creek watershed is located within the Minneapolis-St. Paul Metropolitan area and entirely within Hennepin County. The total area of the watershed is approximately 43 sq. miles and contains portions of nine municipalities: Minneapolis, Robbinsdale, Golden Valley, St. Louis Park, Crystal, New

Hope, Plymouth, Medicine Lake and Minnetonka. Located in a rapidly expanding metropolitan area, approximately 70% of the watershed is in a state of total or partial urban development with urbanization varying from total within the city of Minneapolis to negligible in the western watershed.

8. The average slope of Plymouth Creek, in the upper watershed, from its source to Medicine Lake is approximately 17 feet per mile. From Medicine Lake to the Mississippi River, the slope of Bassett Creek averages approximately 9 feet per mile over its 12.1 mile length. The lower half of the tributary North Branch Bassett Creek drops at approximately 25 feet per mile as does a short reach of the Sweeney Lake Branch, another contributor. Quick runoff combined with relatively few storage areas and existing constrictions such as channel crossings and the tunnel, the only watershed outlet, combine to create flooding all along Bassett Creek.

ALTERNATE PLANS INVESTIGATED

9. The 1976 Feasibility Report has generally provided the project formulation. Authorized for construction by the 1976 Water Resources Development Act on the basis of the Feasibility Report, the project had, and still maintains, a very strong backing from local sponsors and their Congressional representatives. Also, no significant objections were ever made to this flood control project, although several agencies commented on project feature designs or requested that general environmental concerns be acknowledged during construction. There was a consensus among the affected municipalities that this array of features was most appropriate for the highly developed watershed.

10. Upon initiation of post authorization studies in fiscal year 1979, the project sponsors, represented by the Bassett Creek Flood Control Commission, requested the Corps to expedite project design to allow earlier project completion. Upon examination of the project formulated for the watershed, it was determined that the array of proposed structural and non-structural features including the cooperative tunnel and open space flood storage was, indeed, most appropriate and that remaining design could be most productively directed toward verifying project hydrology and hydraulic design; optimizing designs for structural measures, and finalizing layout for project features.

11. On 4 September 1979, a St. Paul District request to delete the Phase I GDM study and advance directly to Phase II was approved. In May 1981, Design Memorandum No. 1, Hydrology and Hydraulics, redeveloped the project hydrology and hydraulic design and supported the Feasibility Report formulation.

12. This submittal of Design Memorandum No. 2, Phase II-General Project Design, advances design for project features. While the general project formulation remains unchanged, many alternative plans for individual project features or groups of features were reviewed. As a result, some authorized project features including road raises, creek clearing and snagging and a reach of floodwall are no longer proposed. Proposed new or modified project features include the slight realignment and altered construction concept for the conduit and a new railroad bridge.

HYDROLOGY

General

13. The basic hydrologic studies were reported in Design Memorandum No. 1, Hydrology and Hydraulics, May 1981. The hydrologic studies included descriptions of the watershed characteristics and climate, the storm characteristics for the basin, the watershed model used to develop runoff hydrographs for synthetic floods and hypothetical floods. It also provided an estimate of the probable maximum flood and standard project flood and an analysis of the flood frequency curves. A brief summary of these studies is given in the following sections.

Climate

14. The project area has a moderate climate typified by warm, humid summers and cold moderately humid winters. The mean annual temperature for the watershed is 44^{o}F. The mean monthly temperature varies from 12^{o}F in January to 72^{o}F in July. Annual precipitation averages 26 inches and average annual snowfall is 44 inches.

Watershed Model

15. The hydrologic analysis of the basin was conducted using the Hydrologic Engineering Center's HEC-1 computer program (723-X6-L2010). The model developed for this study evaluates storm water runoff from 55 subwatersheds forming the Bassett Creek watershed. The subwatersheds vary in size from .06 to 5.77 square miles. The total basin area is approximately 43 squar2 miles. Generally, the outlet for each subwatershed is a restrictive channel crossing which acts as a control for the ponding area upstream.

Discharge-Frequency Curves

16. The watershed model was used to determine discharge frequency curves at 20 locations in the Bassett Creek watershed for ultimate land use and ultimate land use with project in place. The 100-year discharges for these 2 cases are shown in Table 1.

Standard Project Flood

17. The Standard Project Flood was determined for the Bassett Creek watershed using the HEC-1 runoff model. A comparison of Standard Project Flood discharges for ultimate watershed development versus ultimate development with project is shown in Appendix A. There are three reaches where the Standard Project Flood discharges are higher for the with project case than for the without project. These increases do not increase damage potential because the water surface profiles are the same as or lower than the without project condition due to channel modifications.

GEOLOGY AND SOILS

18. Most of the features for this project are small and affect the subsurface to only a shallow depth; therefore, accurate definition of the depth to bedrock and the bedrock statigraphy are not important considerations except for a portion of the proposed tunnel. The geology pertinent to the project consists

of soft alluvial silts and clays, bog deposits of peat, organic rich silts and %lays resting on medium dense glacial sands and tills. Along the proposed tunnel alignment the materials consist of Mississippi River terrace deposits of soft clays, silts, and medium dense sand, medium dense to dense glacial drift and sandstone bedrock of the St. Peter Formation. A detailed discussion of geology and soils is contained in Appendix C. Subsurface explorations, stability analyses, and discussions concerning all elements of geotechnical design can also be found in Appendix C.

INTERIOR DRAINAGE

19. The four areas along Bassett Creek protected by the proposed flood barriers, namely the Western Avenue-Winnetka Avenue area, the Highway 100 North area, the Fruen Mill area below Glenwood Avenue and Bermed area by the conduit entrance, are subject to flooding from interior runoff. The contributing watershed for each area is determined by natural topography, streets, or existing city storm sewer systems. The proposed interior flood control plan for each area includes an outlet in conjunction with a ponding area. An interior ditch is also included in the Highway 100 North plan. The proposed ponding areas and outlets have sufficient capacity to prevent damages from the 100-year event, therefore, pumping stations cannot be justified. Details of the interior flood control analysis and plan are presented in Appendix B.

RECREATION

20. A full analysis of recreation demand, supply, and needs was conducted as part of the March 1976 Feasibility Report. That evaluation, which is still considered to accurately reflect local needs, indicated that there is a need for additional trail developments and parklands in the project area. Recreational concepts/potentials associated with the proposed project have been explored with non-Federal sponsors. However, at this time, a lack of local commitment to development of project-related recreation facilities, availability of local funds for recreation, federal recreational policies, and the general health of the economy have made it impossible to refine the recreation plan contained in the Feasibility Report. Therefore, a recreation plan of development and the associated cost-sharing contract have not been included as project features at this time, although a recognized need and potential for trail developments and park lands still exist.

BEAUTIFICATION AND ENVIRONMENTAL QUALITY PLAN

21. Implementation of the proposed flood control measures involve the removal of many old and/or substandard structures and the construction of new structures through urban areas. Such construction unavoidably impacts existing vegetation in the project area. This loss of vegetation will have varying degrees of adverse visual impacts upon the communities affected. To offset these impacts and thereby make the Bassett Creek project more socially and environmentally acceptable, beautification measures such as landscaping and rustification are proposed as an integral part of the overall project. See Appendix G for details of the beautification plan.

DESCRIPTION OF AUTHORIZED PROJECT

22. The authorized plan for flood control in the Bassett Creek watershed, Hennepin County, Minnesota, involves a combination of both nonstructural and structural measures. A summary description of the project taken from the authorization document reads as follows:

a. "Nonstructural measures include flood proofing of 19 residences and evacuation of 3 residences in the upper watershed and continuance of local flood plain ordinances modified to reflect proposed conditions.

b. The plan includes two principal structural measures; one, a new conduit to replace the existing conduit outletting Bassett Creek to the Mississippi River and the other, a series of small control structures in the upper watershed to temporarily impound flood waters. The lower portion of the new conduit would be constructed in cooperation with the Minnesota Department of Highways under its proposed Interstate Highway program in Minneapolis. Cooperative construction of the new conduit would result in estimated cost savings of about $5.5 million and would prevent severe damages that could occur to industrial developments under present conditions.

c. Other structural measures included in the selected plan in the upper watershed include a limited reach of channel widening, snagging and clearing, road raises, bridge removals, culvert replacements and construction of a new weir at the outlet of Medicine Lake.

d. The temporary flood water storage impoundments and other structural measures acting in conjunction would reduce flood damages to residential developments in the upper Bassett Creek watershed. The new weir structure at the outlet of Medicine Lake would reduce flood water levels of the more infrequent floods and thereby reduce damages to residential properties abutting the lake.

e. None of the features of the selected plan would alter normal streamflow or lake level conditions.

f. Associated features of the selected plan include the development of a permanent marsh impoundment at the entrance to the proposed conduit, which reduces flood damage, provides wildlife enhancement, and contributes to the development of a recreation trail system for bicycling and walking. The trail system would provide a link between existing parks and trails at the lower end of the watershed."

DEPARTURES FROM AUTHORIZED PLAN

23. Post-authorization studies have provided more detailed information on improvements needed to provide design flood protection in the Bassett Creek watershed. A revised study of project hydrology and hydraulic design has altered project design as follows:

a) The conduit sizes were increased from 11 feet to 12 feet diameter for the downstream tunnel portion and from 8.5 feet to 10 feet diameter for the upstream portion.

b) The upstream portion of the conduit has been lowered significantly to go under existing utilities and because of the high cost of cut and cover in this developed area.

c) The authorized plan included the development of a permanent marsh impoundment at the entrance to the proposed conduit. The proposed plan still maintains a flood storage area, but, instead of a permanent marsh, a normally dry surge area providing the required storage volume would be constructed. The creek channel would be relocated and 91 acre feet of storage would be provided in a low surge area graded to allow surface drainage to the creek. The surge area would remain dry at normal creek flows and would provide a potential site for recreational activities.

d) Clearing and snagging from the tunnel storage area to below Glenwood Avenue was eliminated since it did not lower flood stages greatly.

e) Channel enlargement and construction of floodwalls downstream of Glenwood Avenue have been eliminated since adequate freeboard (1.0 foot) below damage elevation is possible within the existing channel. This is now possible because discharges in this reach have been lowered from the Feasibility Report. However, replacement of the lowhead dam (a control on the elevation of Wirth Lake) and some walls for bank stabilization are still required.

f) Replacement of the Soo Line (formerly the Minneapolis, Northfield and Southern) Railroad bridge just downstream from Glenwood Avenue was found necessary since the existing bridge is very obstructive to flow.

g) Relandscaping of Rice Lake to provide additional flood storage was found to be unnecessary. Construction of a roadway across Rice Lake increased the effective storage by reducing the outlet capacity.

h) The culvert replacement at Adair Avenue has been eliminated. The culvert provided drainage for a small corner area at an intersection and has since been covered and is no longer effective. It is not necessary for local storm drainage.

i) Clearing and snagging of Bassett Creek upstream from the Trunk Highway 100 embankment was eliminated since it would have little effect on flood stages in a storage area.

j) All road raises previously proposed to maintain access during the design flood have been eliminated due to the high cost and limited benefits because of short flood durations. Also, conflicts with utilities and storm drainage would occur. In requesting that these project features be eliminated, local authorities have assured that emergency vehicle access throughout the watershed can be accomplished by using other routes. It is believed that no residual safety hazard remains as a result of the road raise deletions.

k) A berm along Winnetka Avenue will be required to prevent water stored by the Wisconsin Avenue control structure from backing into a low, swampy area east of Winnetka Avenue and north of Western Avenue. Normal runoff from the low area will be maintained with a 24" culvert.

PROPOSED STRUCTURES AND IMPROVEMENTS

GENERAL

24. Principal structural flood protection measures for Bassett Creek include a new conduit outlet to the Mississippi River and a series of small control structures in the watershed to temporarily impound floodwaters. Also included in the plan are bridge removals, culvert replacements, a replacement weir structure at Medicine Lake, replacement of a railway bridge and excavation for flood storage. Nonstructural measures include floodproofing 24 residences, acquisition of one residence and continuation of existing floodplain regulations.

CONDUIT

25. The plan for providing an outlet for Bassett Creek flows to the Mississippi River includes abandoning the existing Bassett Creek tunnel beginning at its inlet near 2nd Avenue North and Dupont Avenue and constructing a new tunnel along a new alignment, parts .f which will be completed on a cooperative basis with the Minnesota Department of Transportation (MnDOT). The tunnel will be completed in three major segments with the lower two segments providing cooperative storm drainage for Bassett Creek and new area Interstate Highways.

26. The lower segment of tunnel has been constructed by MnDOT (Feature No. 1) and has been sized to accommodate design Bassett Creek, I-94 and I-394 3rd Avenue Distributor flows. Work has been completed from the tunnel outlet at the Mississippi River, just below the Upper St. Anthony Falls Lock and Dam, to the wye under 2nd Street North, between 2nd Avenue North and 3rd Avenue North. The 2nd Street tunnel is now in use, providing storm drainage for I-94. The 4800 feet of cooperative tunnel in use has been constructed with MnDOT funds and cost allocation is to be based on a ratio of peak design flows generated by each project. A similar methodology and the same frequency of occurrence has been used in the computation of each project's design flows. This cost allocation formula also applies to the middle tunnel segment (Feature No. 2), a cooperative facility to provide storm drainage for Bassett Creek and the 3rd Avenue Distributor of I-394. This tunnel reach from the existing wye upstream to the proposed drop inlet location for I-394 flows near 7th Street North and 3rd Avenue North will be constructed by the Corps of Engineers. The Corps will also construct the proposed drop inlet structure, as requested by MnDOT.

27. The upper reach of tunnel (Feature No. 3) from the I-394 inlet drop structure to the control/drop structure near 2nd Avenue North and Dupont Avenue will be constructed by the Corps solely for Bassett Creek flows.

28. Plates 3 and 4 show the lower tunnel segment plan and profile as constructed by MnDOT. Plates 5 through 7 show the upper two segments of tunnel in plan and profile. All 3 reaches of tunnel will receive additional study in a tunnel feature design memorandum due for submittal in October 1983. The tunnel feature design memorandum will also advance design on the tunnel inlet storage area and the drop structure to the storage area.

CONTROL STRUCTURES

29. Control structures with overflow weirs and low flow orifices will be constructed at six locations throughout the watershed to temporarily impound

runoff. Three such structures will be located in the city of Golden Valley - one at the location of a proposed new main stem Bassett Creek crossing for Wisconsin Avenue (Feature No. 20), one in the Golden Valley Country Club golf course (Feature No. 19), and one at the Bassett Creek crossing of Trunk Highway 55 (Feature No. 10).

30. Two control structures will be located in the city of Crystal - one, the Edgewood Embankment (Feature No. 31), near the intersection of 36th Avenue North and Douglas Drive, and the other at the main stem Bassett Creek crossing of Trunk Highway 100 (Feature No. 16). One control structure will be provided in the city of Minneapolis at the tunnel inlet near the intersection of 2nd Avenue North and Dupont Avenue (Feature No. 5A). A flood storage area (Feature No. 5) will be excavated immediately upstream, southwest of the control structure, in an undeveloped area bounded by the Burlington Northern railroad on the south, Cedar Lake Road on the west and the existing creek bed on the north. The existing control structure for Medicine Lake will be removed and replaced (Feature No. 21) just downstream, south of South Shore Drive, at the Northwestern Railroad bridge over Bassett Creek. The railroad embankment will serve as the tie-back for the control structure.

31. Each control structure will leave the creek virtually unaffected during normal flow conditions. Storage occurs with increasing runoff and quantities stored vary with with the site and timing and intensity of rainfall. Storage under design 100 year event conditions are generally measured in hours and storage levels will begin to recede when runoff to the storage areas is reduced to levels below the discharge at the control structures. For lesser frequency events, storage upstream for control structures will generally result in higher water levels under proposed conditions and relatively more maintenance will likely be required in park areas after rainfall events. The effect of each control structure will be to lower peak discharges immediately downstream. The combined effect of all storage will be to decrease the size of the outlet conduit and reduce measures to increase stream capacity.

BRIDGE REMOVALS

32. The timber bridge over Bassett Creek at Minnaqua Avenue (Feature No. 15A) represents an unnecessary constriction since this crossing is not needed by local traffic. The creek can be crossed at Regent Avenue, approximately 1 city block away. The bridge and the abutments will be removed and relandscaped to match the adjoining grounds. The nine residences on Minnaqua Avenue east of the creek will front a dead-end street with a cul-de-sac near the creek. Just west of the creek, Minnaqua Avenue immediately intersects with Scott Avenue. Through traffic along Scott Avenue and Minnaqua Avenue will not be affected. At the Penn Avenue crossing of Bassett Creek in Minneapolis (Feature No. 8) an old bridge crossing remains intact under a new bridge built well overhead. Although the old bridge, a large concrete box structure, lies in a park area, it is not used as a crossing except occasionally by pedestrians. Access across the creek can be accomplished on the new bridge above. The old Penn Avenue crossing will be removed and relandscaped.

CROSSINGS

33. Proposed new culvert crossings are required for increased capacity at 6 locations in the city of Crystal and 3 locations in the city of Golden Valley. The Golden Valley replacements are located at Noble Avenue (Feature No. 13),

Regent Avenue (Feature No. 14) and Westbrook Road (Feature No. 18). Replacement culverts to be provided in Crystal are located at 32nd Avenue (Feature No. 23), Brunswick Avenue (Feature No. 24), 34th Avenue (Feature No. 28), Douglas Drive (Feature No. 29), Georgia Avenue (Feature No. 33) and the crossing at 36th and Hampshire Avenues (Feature No. 34).

34. All of the proposed culvert crossings except for the Westbrook Road and Douglas Drive culverts will be constructed and in use by the end of the 1982 construction season. The city of Golden Valley will complete this work under the Section 215 (P.L. 90-483) agreement. Two of the crossings, at Noble and Regent Avenues, will use a new arch-bridge type structure which maintains the creeks natural bed. The arch-bridge structures were bid on as alternate designs. Based on bids received, the city of Golden Valley decided to use the alternate designs which are considered to be hydraulic equivalents of the designs shown on Plate 21. See Appendix I for the alternate designs.

<u>RAILROAD BRIDGES</u>

35. The Soo Line Railroad bridge crossing of Bassett Creek in Minneapolis near the intersection of Glenwood and Inglewood Avenues (Feature No. 9B) represents a potentially serious creek obstruction capable of causing localized flooding in the industrial mill area. This bridge will be removed and replaced along a slightly modified alignment to utilize a shorter bridge span and allow a larger open flow area.

36. The Northwestern Railroad bridge over Bassett Creek just downstream from the outlet of Medicine Lake in the city of Plymouth (Feature No. 21) will require minor modifications. A concrete channel bottom slab and new lagging to prevent abutment earth slippage are proposed.

DIVERSION DURING CONSTRUCTION

37. Many of the project features along Bassett Creek, including each of the control structures and culverts, will require the creek to be diverted temporarily during construction. Other than the tunnel, none of the structures are massive or difficult to construct so that the duration of creek diversion will be short. Normal creek flows are small with most areas of the creek having discharges less than 100 cfs. Therefore, control and diversion of the creek during construction is not considered a significant problem. During the lengthy tunnel construction, the creek will continue to flow through the existing conduit and only minor earth work may be required to keep potential high water levels from flooding the tunnel inlet.

ACCESS ROADS

38. Existing public roads will be used for access to project construction sites. U.S., State, county, and city roadways provide access to all project areas. Most roadways are well maintained and of high quality, capable of accommodating transportation of construction equipment and materials. City streets are generally adequate for transportation to project areas and it is possible to route heavy or oversized loads around bridges or other structures with limited capacity. Access can be gained to each construction site by more than one route. No new roads other than short, temporary construction accesses off existing public roadways are necessary. Such temporary accesses will be restored to their original condition upon completion of construction.

CONSTRUCTION MATERIALS

General

39. Much of the berm and embankment material required for the project will be generated by excavation of project flood storage areas. The remainder of construction materials required can be acquired from area commercial sources.

Levee and Berm Fill

40. Fill to be used in the Edgewood embankment and the Golden Valley Country Club embankment is to be acquired from excavation of the Edgewood storage area. Fill to be used in the tunnel storage area berm will be acquired either from the tunnel excavation or excavation of the adjoining flood storage area. Fill to be used in the Wisconsin Avenue embankment, the Winnetka Avenue dike and the T.H. 100 embankment will be acquired from available sources in the Twin City metropolitan area.

Other Construction Materials

41. Suitable materials for riprap, bedding, concrete aggregates and concrete are produced from several tested sources in or near the metropolitan area. Further discussion of material sources is given in Appendix C.

ENVIRONMENTAL

42. After completion of the feasibility report in March 1976 and the final environmental impact statement (FEIS) in March 1977, a number of project components were modified, added, or deleted. Deletions include both channel (i.e., clearing and snagging, channel widening) and structural (i.e., road raises, floodwalls, culvert replacement) components that were eliminated as a result of improved hydrologic data and a need to lessen social disruption. The modifications to project components and component additions also resulted from hydrologic studies and a need to reduce social disruption and environmental impacts. Basically, the modifications and additions include: changing the size (from 8.5 fee0 (ft) to 10.0 ft in diameter) and construction methods (from surface to subsurface excavation) of the outlet conduit, redesigning the tunnel inlet storage area to make it a temporary ponding area instead of a shallow wetland, relocatng the Minneapolis-Northfield and Southern Railroad bridge plus part of the creek channel, sheet-piling a portion of the creek bank and constructing an interior drainage site in the Fruen Mill and Glenwood-Inglewood area, relocating and realigning the T.H. 100 control structure, widening the outlet channel, and reducing and changing the nature of the outlet control structure (from a levee to a sheet-piled weir) downstream of Medicine Lake.

43. These changes in the project would not have a significant cumulative impact on the social, cultural, and natural resources within the project area. Although each modified and additional component would have some effect on the natural resources of the project area, the cumulative effects would be less than the impacts identified in the FEIS.

44. The effects of disposing of excavated material and placing fill material in the aquatic environment were also evaluated. Of particular importance was the placement of excavated materials from the tunnel inlet storage area. This area had been used for approximately 30 years as a construction debris disposal site,

and there was some concern about the quality of the material to be excavated because most of this material would be placed around the proposed storage area. as a result, two alternative disposal sites were identified.

45. Placement of fill material into the aquatic environment would result in both temporary and permanent losses of aquatic habitat. However, using clean fill, placing temporary levees around some construction sites, and conducting construction activities during low-flow periods should minimize the potential for adverse impacts.

46. These changes in the proposed project and the effects of placing fill material into the aquatic environment are discussed more fully in the environmental assessment and Section 404(b)(1) ib oages EA-1 through 18.

REAL ESTATE REQUIREMENTS

47. The local sponsor will be required to provide without cost to the United States all lands, easements, and rights-of-way, including borrow areas, disposal areas, and ponding areas, as determined by the Chief of Engineers, for construction, operation and maintenance of the project. All real estate interests will be acquired in compliance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646.

48. In accordance with Section 221 of the Flood Control Act of 1970, the local sponsor will furnish assurances satisfactory to the Secretary of the Army that it will:

a. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved 2 January 1971, in acquiring lands, easements and rights-of-way for construction and subsequent maintenance of the project and inform affected persons of pertinent benefits, policies and procedures in connection with said Act; and

b. Comply with Section 601 of Title IV of the Civil Rights Act of 1964 (P.L. 88-352) and Department of Defense Directive 5500.11 issued pursuant thereto with the construction and operation of the project.

49. Plan drawings showing required project lands are now being prepared for delivery to the City of Minneapolis. These drawings will present detailed information suitable for preparing easement and parcel descriptions of property to be acquired. Surveying information defining these properties will be based on existing nearby land ownership property corner points, section or sub-section corner points, State plain coordinate grid points or other suitable reference points.

RELOCATIONS

Telephone and Electrical Utilities

50. No permanent telephone or electrical relocations are anticipated. Temporary interruptions to service may be required to accommodate construction of individual project features but facilities are expected to be restored to their original condition. Costs of any such relocations are considered non-Federal expenses.

Natural Gas Utilities

51. Approximately 100' of 12" steel gas main will have to be lowered to accommodate the removal of the concrete box culvert at Penn Avenue. Cost of this work is considered a non-Federal expense.

Railroads

52. Two railroad modifications are anticipated in this project. The Chicago and Northwestern Railroad bridge in Plymouth just downstream from the outlet of Medicine Lake will require minor modifications to the abutments and creek bed area. A second railroad modification involves the removal and replacement of the Soo Line railroad bridge near Glenwood-Inglewood Avenues in Minneapolis. The bridge will be replaced with a shorter span structure along a new alignment and will not be as obstructive to flow as the existing structure. The realignment will require modifications to the tracks leading to the structure from both directions for distances dictated by minimum radius requirements. These railroad modifications are considered Federal cost items.

Sanitary Sewers

53. The existing Currie Avenue 86" brick and stone sanitary sewer in Minneapolis from just west of Freemont Avenue North to Dupont Avenue North will be abandoned and replaced by a 84" RCP-A pipe approximately 862 feet long as shown on Plate 12. This work involves taking up and relaying some trackage from the Soo Line (formerly Minneapolis, Northfield and Southern) Railroad. Any other alignment would be longer and increase construction conflicts with existing buildings, streets and utilities. The work involving the Railroad is generally considered a Federal cost item, and the remainder of the work is considered a non-Federal cost item.

54. At the T.H. 100 embankment, approximately 360 feet of 8" V.C.P. will be replaced with 8" P.V.C. pipe.

55. At the Edgewood embankment and storage area site, approximately 1365 feet of 10" V.C.P. sanitary sewer would be replaced with cast iron pipe along a new alignment.

56. Provision will be made to maintain service throughout construction and this work will be coordinated with the appropriate municipality and the Metropolitan Waste Control Commission. Modifications to sanitary sewers are considered local cost items.

Watermain

57. Approximately 85 feet of 24" ductile iron watermain will have to be lowered to accommodate removal of the concrete box culvert at Penn Avenue.

58. To complete the removal of Georgia Avenue, approximately 100' of 6" watermain will be insulated as a result of the storage area excavation. This will be completed under the Section 215 program.

59. With the removal of the Soo Line Railroad bridge near Glenwood and Inglewood Avenues in Minneapolis, a 6-inch water line attached to the bridge providing water to the Glenwood-Inglewood Company will be removed. It will be

relocated on the new bridge and provisions will be made for temporary water service during bridge construction.

60. Construction of the T.H. 100 embankment will require replacement of approximately 360 feet of 6" watermain with ductile iron pipe.

61. It is believed that water service to all properties near these construction sites can be maintained during construction, but that pressure may be reduced.

62. Modifications to water mains are considered local cost items.

Fences

63. Up to several hundred feet of security fencing will be removed and replaced, if necessary, at the Golden Valley Country Club near the proposed embankment. This work is necessary to allow construction access to the embankment site and is considered a Federal cost item incidental to the embankment construction.

Low Head Rock Dam

64. The low head rock dam near the Fruen Mill in Minneapolis has been recommended to be relocated as a non-Federal cost item by the Board of Engineers for Rivers and Harbors. In 1976, the Office of the Chief of Engineers concurred with this recommendation. Therefore, this item is considered a non-Federal cost item.

Medicine Lake Outlet

65. The Board of Engineers for Rivers and Harbors recommended this work item to be completed at local expense. The Office of the Chief of Engineers concurred and therefore, this item is considered a non-Federal cost item.

Road Raises

66. The Board of Engineers for Rivers and Harbors recommended that the raising and resurfacing of roads at 29th Avenue and Boone Avenue be completed at local expense, the necessity due to downstream controls and storage area real estate policies. The Office of the Chief of Engineers concurred. The Boone Avenue road raise is now no longer recommended as a project feature and, therefore, will not be considered a local cost item. The 29th Avenue road raise, however, is necessary as a part of the T.H. 100 embankment structure. It is recommended that the fill portion of the road raise required for the embankment and related construction be considered Federal cost items and that ramp material not necessary for the embankment, resurfacing materials and related construction be considered local cost items. All other road raises proposed in the Feasibility report are no longer proposed for construction.

COST ESTIMATE

Basis of Estimate

67. This general design memorandum estimate of costs is based on October 1982 price levels and, wherever possible, reflects recent prices for similar work in the St. Paul District. A summary comparison of project costs between the

current approved estimate (PB-3, 26 March 1982) and the revised estimate prepared for this design memorandum is shown in Table 1. Details of the revised cost estimate can be found in Appendix F.

Table 1 - Summary Comparison of Estimated First Costs

	Current Approved Est. (PB-3, 26 Mar 82)	Phase II GDM Estimate
Federal First Costs and Non-Federal Contributions		
Relocations	$ 629.0	$ 540.0
Channels	9,031.0	16,612.0
Floodwalls	704.0	0.0
Recreation Facilities	271.0	0.0
Flood Control Structures	790.0	1,105.0
Engineering and Design	1,791.0	2,720.0
Supervision and Administration	737.0	1,783.0
Inspection	(417.0)	(822.0)
Overhead	(320.0)	(961.0)
Total Cost (Federal First Costs & Non-Federal Contributions)	$13,953.0	$22,760.0
Non-Federal Contributions	253.0	460.0
Total Federal First Costs	$13,700.0	$22,300.0
Non-Federal First Costs		
Lands and Damages	$ 3,040.0	$ 3,740.0
Relocations	1,847.0	2,040.0
Non-Federal Contributions	253.0	460.0
Total Non-Federal First Costs	5,140.0	6,240.0
Total Project First Costs	$18,840.0	$28,540.0

The difference in Federal first cost (an increase of $8,600,000) between this design memorandum cost estimate ($22,300,000) and the current approved estimate from PB-3 effective October 1982 ($13,700,000) is attributable to the following:

a.	Relocations	$ -89,000
	(1) Increase in residences to be floodproofed from 19 to 24	(+129,000)
	(2) Decrease to elimination of three home relocations	(-360,000)
	(3) Increase due to addition of railroad bridge relocation	(+142,000)
b.	Channels - Conduit	+6,855,000
	(1) Increase due to Federal share of costs for Mn/DOT 2nd St. Tunnel	(+919,000)
	(2) Increase due to Federal share of costs for 3rd Ave. Tunnel	(+1,820,000)
	(3) Increase due to redesign of tunnel, increase in length of tunnel, change from open-cut to tunnel construction, and increase in unit tunnel costs based on current construction in area	(+4,116,000)
c.	Channels - Channel Modifications	+1,279,000
	(1) Increase due to transfer of work from Floodwall category and redesign at Fruen Mill area	(+264,000)
	(2) Increase due to bridge removal and associated channel work at Penn Avenue	(+51,000)
	(3) Increase due to change from open channel cut to closed conduit RCP at Markwood Area	(+967,000)
	(4) Decrease to estimated cost for bridge removal at Minnaqua Avenue	(-3,000)
d.	Channels - Storage Areas	-544,000
	(1) Decrease due to refined design and current unit costs at tunnel inlet ponding area	(-556,000)
	(2) Decrease in estimated cost of beautification	(-23,000)
	(3) Increase due to addition of storage area at Edgewood	(+154,000)
	(4) Decrease due to elimination of road raises	(-119,000)
e.	Flood Control Structures	+315,000
	(1) Increase due to redesign of tunnel inlet drop structure	(+78,000)
	(2) Decrease due to redesign of Highway 55 control structure	(-41,000)
	(3) Increase due to redesign of Highway 100 flood control structure	(+126,000)
	(4) Increase due to redesign of Golden Valley Country Club flood control structure.	(+123,000)
	(5) Increase due to redesign of Edgewood	(+56,000)
	(6) Increase due to redesign of Wisconsin Avenue	(+29,000)
	(7) Decrease due to redesign of Winnetka Avenue berm to project	(-56,000)

f. Floodwalls
Decrease due to reclassification and inclusion with channel modifications -704,000

g. Recreation
Decrease due to elimination of recreation facilities from project -271,000

h. Engineering and Design
Increase due to direct proportion of estimated construction costs +929,000

i. Supervision and Administration
Increase due to direct proportion of estimated construction costs +1,046,000

j. Non-Federal Contributions
Increase due to floodproofing and tunnel cost share +207,000

The difference in non-Federal first cost ($1,100,000) between this design memorandum cost estimate ($6,240,000) and the current approved estimate from PB-3 effective October 1982 ($5,140,000) is attributable to the following:

a. Lands and Damages
Increase due to project damages and current price levels +700,000

b. Relocations
Increase due to more accurate estimates and bids received for work +193,000

c. Non-Federal Contributions
(1) Increase in residences to be floodproofed (+27,000)
(2) Increase in Mn/DOT participation in 3rd Ave. Tunnel (+180,000)

OPERATION AND MAINTENANCE

68. Local Interests will maintain the project in accordance with procedures and schedules set forth in a maintenance manual to be furnished by the Corps of Engineers. Maintenance will consist of periodic inspection and repair as required on the tunnel, control structures including the Medicine Lake control structure, and the crossings. Maintenance schedules and instructions will be furnished to the appropriate local officals for completed features of the project as soon as they become functional. This will ensure proper operation of the partially completed project during the extended period required for construction of the total project.

SCHEDULE FOR DESIGN AND CONSTRUCTION

69. The schedule for design and construction is presented in Table 2 and is subject to the availability of funds. In scheduling construction, two reaches are used. Construction in the upper watershed is being scheduled ahead of construction in the lower watershed, largely due to the need for a feature design memorandum for the tunnel in the lower watershed. Previously, the point defined as separating the upper reach from the lower reach was the point where Golden Valley Road crosses the main stem Bassett Creek in the city of Golden Valley. It is now recommended that the lower watershed be defined as that portion of the watershed lying within the boundaries of the city of Minneapolis. Only one feature, the T.H. 55 control structure (Feature No. 10), is affected by this change in reach definition. This feature will now go to construction earlier with the upper reach features.

TABLE 2 - Schedule for Design and Construction

Reach	Submit Feature Design Memo	Submit P&S	Advertise	Award	Construction Completion
Upper	N/A	Aug 83	Feb 84	Mar 84	Oct 85
Lower	N/A	Apr 84	Jun 84	Jul 84	Dec 86
Lower	Oct 83	Apr 84	Jun 84	Jul 84	Dec 86

STATEMENT OF FINDINGS

INTRODUCTION

I have reviewed and evaluated, in light of the overall public interest, the documents concerning the proposed plan and the stated views of other interested agencies and the concerned public in formulating and developing a plan for flood damage reduction in the Bassett Creek Watershed, Hennepin County, Minnesota.

BACKGROUND

The Bassett Creek Watershed flood control project was authorized in the 1976 Water Resources Development Act of 1976 (P.L. 94-587). The project will provide protection against a 100-year frequency flood occuring in any given year for residential development in the upper watershed and commercial and industrial development in the lower watershed. These areas together with several major highways and railroads are subject to frequent flooding. A large commercial and industrial area in Minneapolis considered especially susceptible to flood damage is located immediately upstream of the 1.5 mile tunnel which serves as an outlet for the entire Bassett Creek watershed. A 50 percent blockage of this tunnel would cause flooding on more than 250 acres including 450 residential dwellings and 80 industries. Flood losses could exceed $12.5 million in the proximity of the existing tunnel entrance. Severe flood damages also occur in the communities of Golden Valley, New Hope, and Crystal.

Recent severe flooding in the Bassett Creek watershed occurred in 1974, 1975, and 1978. Summer rainstorms and snowmelt during the spring often increased by rainfall are the major causes of flood damage in the watershed. A related problem caused by the rain and flooding is sanitary sewer backup in many homes. A more severe flood occurred in June 1942. This flood was significant because of the damage which was incurred by the commercial and industrial establishments in Minneapolis. If a flood of this magnitude were to occur at this time, damages of approximately $2.9 million would occur in Minneapolis and damages of approximately $7.7 million would be sustained through the remainder of the watershed.

Flood damages presently average about annually without flood protection. The project will provide flood protection for some residences and industries located in the floodplain, and an indeterminate amount of commercial and industrial development in Minneapolis.

ALTERNATIVES

In addition to the no action alternative, all of the other available means of reducing flood damages were investigated as alternatives to the proposed action.

The no action alternative was not considered responsive to the needs of the people.

Nonstructural alternatives such as flood insurance, improved flood warning systems and reliance on emergency protective measures, flood plain regulations and flood proofing techniques by themselves or in combination would partially reduce the present and potential flood problems of the watershed, but would not feasibly reduce potential damages to existing developments in the flood plain.

A permanent evacuation plan eliminating all damages is economically infeasible, especially in the lower watershed where the primary problem is the deteriorated condition of the existing conduit and the flooding that could result with its failure. In addition, evaucation is unacceptable to the people who would be directly affected.

Structural alternatives involving large-scale channel modifications and leve2s alone or in combination in the upper watershed would be economically infeasible or would be environmentally and socially undesirable.

Alternatives involving repair of the existing conduit, a new conduit in non-highway right-of-way, and others involving a new conduit along various other highway right-of-way alignments were investigated and found to be feasible but more costly than the selected conduit alignment.

An alternative involving an open channel with open space corridor in lieu of a new conduit was viewed by some local interests as a more environmentally desirable plan since it would restore the creek to its natural state. The Feasibility Report recognized this and identified the open channel-open space alternative as the best plan from the standpoint of environmental quality (EQ). However, the report concluded that the open channel-open space alternative is unacceptable since the costs of development would far outweigh the benefits obtainable and to await the results of more detailed studies of the open channel-open space alternative would result in losing the opportunity to develop a cooperative conduit plan with the Minnesota Department of Highways. Development of the new conduit proposal does not preclude future development of the open channel-open space plan by local interests.

THE SELECTED PLAN

The selected plan for the Bassett Creek watershed involves a combination of both nonstructural and structural measures. Nonstructural measures include flood proofing of 24 residences and evacuation of 1 residence in the upper watershed and continuance of local flood plain ordinances modified to reflect proposed conditions.

The plan includes two principal structural measures; one, a new conduit to replace the existing conduit outletting Bassett Creek to the Mississippi River and the other, a series of small control structures in the upper watershed to temporarily impound flood waters. The lower portion of the new conduit has been constructed by the Minnesota Department of Transportation under its Interstate Highway program in Minneapolis. This new conduit has been sized to accomodate future Bassett Creek flows. Cooperative construction of the conduit system will result il estimated cost savings to about $5.7 million and would prevent severe damages that could occur to industrial developments under present conditions.

Other structural measures included in the selected plan in the upper watershed include a limited reach of channel widening, bridge removals, culvert replacements and construction of a new weir at the outlet of Medicine Lake.

The temporary flood water storage impoundments and other structural measures acting in conjunction would reduce flood damages to residential developments in the upper Bassett Creek watershed. The new weir structure at the outlet of Medicine Lake would reduce flood water levels of the more infrequent floods and thereby reduce damages to residential properties abutting the lake.

None of the features of the selected plan would alter normal streamflow or lake level conditions.

Another feature of the selected plan includes the development of a flood storage area at the entrance to the proposed conduit, which will reduce flood damage, provide a potential recreational area, and contribute to the potential development of a recreation trail system for bicycling and walking. Such a trail system would provide a link between existing parks and trails at the lower end of the watershed.

EVALUATION

Environmental Considerations - The selected plan was developed in response to concerns expressed by local interests who wished to preserve the aesthetic quality of Bassett Creek. Accordingly, such environmentally degrading features as channel modification and snagging and clearing were eliminated in the more environmentally sensitive areas of the creek in favor of temporary flood water storage which, because of short duration, would not cause a significant impact on the environment.

Coordination with the U.S. Fish and Wildlife Service and the Minnesota Department of Natural Resources resulted in development of a plan that would minimize adverse impacts on northern pike spawning habitat and yet adequately reduce flood damages to residences on Medicine Lake.

The selected plan includes excavation of two of the temporary flood water storage areas. Adverse environmental impacts could be expected during construction of these and other features of the selected plan. Adverse impacts on water quality and aquatic organisms would be temporary. Some long-term adverse effects would occur from embankment construction due to the removal of vegetation and the associated effects on aesthetic qualities and wildlife habitat. The new outlet structure at Medicine Lake would be constructed in a wetland about 500 feet downstream of the lake.

Some long-term beneficial environmental impacts would result with implementation of the selected plan. The new conduit will be constructed with a drop which will effectively prevent the migration of rough fish from the Mississippi River into Bassett Creek. In the upper watershed the storage impoundments would retard high velocity flood flows thereby possibly reducing downstream degradation and aggradation problems.

Social Considerations - The selected plan would provide the flood protection considered necessary for Minneapolis and the other suburban communities in the Bassett Creek watershed. Direct benefits would accrue from the protection of some residences and industries located in the flood plain and an indeterminable amount of commercial and industrial development in Minneapolis that could be severely damaged if the existing conduit failed or became blocked during a flood. The selected plan would reduce the threat of life and the anxieties commonly associated with flooding.

The selected plan would place a social burden upon one family which will be evacuated from the flood plain and possibly upon those property owners whose residences would be raised or floodproofed. Although flood proofing measures are considered optional by the Federal government, the city of Golden Valley has determined that each residential structure will be protected against the design flood. To date, the homeowners have participated in the program.

Cultural Considerations

Cultural resources studies completed for this Phase II study by the St. Paul District, Corps of Engineers have failed to identify any archaeological or historical sites in the project area. However, a potential for previously unknown culturally valuable sites is felt to exist and construction activities will be required to remain cognizant of this potential.

Economic Considerations - Annual benefits and costs are $2,802,100 and $2,329,200, respectively for the project. The benefit-cost ratio is 1.2. In additiol to an estimate for the prevention of present and future flood damages, the benefit estimate includes an estimate for early replacement of existing facilities, an estimate of the economic gains resulting from increased recreation opportunities and employment, and an estimate of early real estate acquisition activities by sponsoring communities to prevent development in floodplain areas prior to recent adoption of floodplain management regulations.

The opportunity to develop the plan cooperatively with the Minnesota Department of Transportation also results in a significant economic gain. With out this opportunity the plan would most likely not be economically feasible.

The selected plan would cause no significant adverse impact on the existing tax base of school districts. On the contrary, property values and hence the tax base could increase with implementation of the plan.

CONCLUSION

I find that the action proposed herein is based on a thorough analysis and evaluation of all reasonable alternative means for achieving the stated objectives; that wherever unavoidable adverse effects are found to be involved, they cannot be avoided by reasonable alternative courses of action which would achieve the congressionally specified project purpose; that the recommended action is consonant with national policy, statutes, and administrative directives; that where the proposed action results in an adverse effect, this effect is either mitigated or outweighed by other considerations. In addition, the city of Minneapolis, the Minnesota Department of Transportation, the Bassett Creek Flood Control Commission and the communities it represents find the plan acceptable in concept. Accordingly, it is my decision that the public interest would best be served by implementation of the plan.

RECOMMENDATION

I recommend that the United States construct the flood storage and conveyance facilities, flood proofing modifications and related features in the Bassett Creek watershed at Hennepin County, Minnesota, for flood control, in general accordance with the plan selected herein, with such modifications thereof as in the discretion of the Chief of Engineers may be advisable at an estimated Federal first cost of $22,300,000, non-Federal first cost of $6,240,000

and non-Federal annual operation, maintenance, and replacement costs of $17,500 provided that prior to construction, and in accordance with Section 221 of the Flood Control Act of 1970, local interests furnish assurances satisfactory to the Secretary of the Army that they will:

a. Provide without cost to the United States all lands, easements, and rights-of-way, including borrow areas and disposal areas for excavated material determined suitable by the Chief of Engineers and necessary for construction of the project;

b. Hold and save the United States free from damages that may result from construction of the project, not including damages due to the fault or negligence of the United States or its contractors;

c. Maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army;

d. Share in the cost of the nonstructural portion of the project in accordance with cost-sharing provisions being developed under Section 80 of Public Law 93-251;

e. Accomplish without cost to the United States all relocations and alterations of buildings, transportation facilities, storm and sanitary sewer systems, public and private utilities, local betterments, drainage facilities, and other structures and improvements made necessary by construction of the recommended plan, excluding railroad bridges and approaches and facilities necessary for the normal interception and disposal of local interior drainage at the line of protection;

f. Prescribe and enforce regulations to prevent obstruction or encroachment on channels and temporary storage areas which would reduce their flood-carrying or storage capacity or hinder maintenance and operation;

g. Provide a cash contribution for recreation equal to 50 percent of the final separable cost allocated to this function less a credit for the value of lands, easements, rights-of-way, alterations, and relocations allocated therefor;

h. Publicize flood plain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to insure compatibility between future development and protection levels provided by the project; and

i. At least annually inform affected interests regarding the limitations of the protection afforded by the project.

j. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, approved 2 January 1971, in acquiring lands, easements and rights-of-way for construction and subsequent maintenance of the project and inform affected persons of pertinent benefits, policies and procedures in connection with said Act; and

k. Comply with Section 601 of Title VI of the Civil Rights Act of 1964 (P.L. 88-352) and Department of Defense Directive 5500.11 issued pursuant thereto and published in part 300 of Title 32, Code of Federal Regulations, in connection with the construction and operation of the project.

Further, I recommend that non-Federal interests (the Minnesota Department of Transportation or the local sponsor) be reimbursed for the full amount of any costs they have incurred toward payment of the allocated Federal share of the cooperative drainage facilities currently estimated at approximately $3,000,000 for advance work on the cooperative tunnel and $450,000 for advance engineering and construction work on upper watershed project features under the Section 215 agreement.

EDWARD G. RAPP
Colonel, Corps of Engineers
District Engineer

BASSETT C

FLOOD CONTROL

FEATURE NUMBER	SHEET NUMBER	DRAWING NUMBER	DESCRIPTION
	1	M34.3-R-5/180	TITLE AND INDEX
	2	M34.3-R-5/181	PROJECT LOCATION AND VICINITY MAP
1	3	M34.3-R-5/182	MNDOT TUNNEL PLAN AND PROFILE STA 15+00 TO 50+00
1	4	M34.3-R-5/183	MNDOT TUNNEL PLAN AND PROFILE STA 50+00 TO 85+00
2	5	M34.3-R-5/184	TUNNEL STA. 40+00 TO 66+50 PLAN & PROFILE
3	6	M34.3-R-5/185	TUNNEL STA 20+00 TO 40+00 PLAN & PROFILE
4	7	M34.3-R-5/186	TUNNEL STA. 0-25 TO 20+00 PLAN & PROFILE
	8	M34.3-R-5/187	TUNNEL SECTIONS AND DETAILS
5A	9	M34.3-R-5/188	INLET STRUCTURE
5	10	M34.3-R-5/189	TUNNEL INLET PONDING AREA
5	11	M34.3-R-5/190	TUNNEL INLET PONDING AREA BORING LOGS AND DROP STRUCTURE
5	12	M34.3-R-5/192	INLET PONDING AREA SEWER BETWEEN CURRIE AND DUPONT
5	13	M34.3-R-5/193	DELETED
8	14	M34.3-R-5/194	PENN AVE CULVERT REMOVAL
9 & 9A	15	M34.3-R-5/195	FRUEN MILL CHANNEL IMPROVEMENTS PLAN
9	16	M34.3-R-5/196	FRUEN MILL PONDING AREA
9	17	M34.3-R-5/197	FRUEN MILL AREA RETAINING WALL DETAILS
9	18	M34.3-R-5/198	FRUEN MILL AREA RETAINING WALL AND SECTIONS
9B	19	M34.3-R-5/199	FRUEN MILL AREA RAILROAD BRIDGE AND DROP STRUCTURE DETAILS
10	20	M34.3-R-5/201	HIGHWAY 55 CONTROL STRUCTURE PLAN & SECTIONS
13 & 14	21*	M34.3-R-5/202	CULVERT REPLACEMENT AT NOBLE AND REGENT AVE.
15A & 28	22*	M34.3-R-5/203	BRIDGE REMOVAL @ MINNAQUA AVE AND CULVERT REPLACEMENT @ 34TH AVE
16	23	M34.3-R-5/204	HIGHWAY 100 EMBANKMENT PLAN AND PROFILE
6	24	M34.3-R-5/205	HIGHWAY 100 EMBANKMENT PROFILE AND SECTIONS
6	25	M34.3-R-5/206	HIGHWAY 100 EMBANKMENT TYPICAL SECTIONS
6	26	M34.3-R-5/207	HIGHWAY 100 EMBANKMENT EXCAVATION, SECTION AND CONDUIT PROFILE

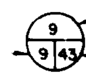
FEATURE NUMBER	SHEET NUMBER
6	[illegible]
18	[illegible]
19	[illegible]
19	[illegible]
20	[illegible]
20	32
20A	[illegible]
21	34
23 & 24	35
29	[illegible]
29	[illegible]
31	[illegible]
31	[illegible]
31A & 32	40
31A	[illegible]
33	[illegible]
34	43
35	[illegible]

NOTES

1. FEATURE NUMBERS REFER TO FEATURES INDICATED ON SHEET 2
2. FEATURE NUMBERS MARKED * INDICATE DESIGNS WERE DEVELOPED FOR THE CITY OF GOLDEN VALLEY, MINNESOTA BY BARR ENGINEERING CO IN ACCORDANCE WITH AN AGREEMENT BETWEEN THE CITY OF GOLDEN VALLEY AND THE CORPS OF ENGINEERS UNDER SECTION 215 OF P L 90-483

LEGEND

NUMBER OF SHEET ON WHICH CONDITION IS SHOWN ---



DETAIL OR SECTION ID

NUMBER OF SHEET ON SECTION OF THE COND

ETT CREEK

ONTROL PROJECT

FEATURE NUMBER	SHEET NUMBER	DRAWING NUMBER	DESCRIPTION
16	27	M34.3-R-5/208	HIGHWAY 100 EMBANKMENT CONTROL STRUCTURE PLAN AND SECTIONS
18	28	M34.3-R-5/210	CULVERT REPLACEMENT @ WESTBROOK ROAD
19	29	M34.3-R-5/211	GOLDEN VALLEY COUNTRY CLUB EMBANKMENT PLAN PROFILE AND SECTIONS
19	30	M34.3-R-5/212	GOLDEN VALLEY COUNTRY CLUB EMBANKMENT BORING LOGS AND SECTIONS
20	31*	M34.3-R-5/213	WISCONSIN AVE EMBANKMENT PLAN AND PROFILE
20	32*	M34.3-R-5/214	WISCONSIN AVE EMBANKMENT SECTION AND DETAILS
20A	33	M34.3-R-5/216	WINNETKA AVE PLAN AND PROFILE
21	34	M34.3-R-5/217	MEDICINE LAKE OUTLET STRUCTURES PLAN AND DETAILS
23 & 24	35*	M34.3-R-5/218	CULVERT REPLACEMENTS @ BURNSWICK AND 32ND AVE
29	36	M34.3-R-5/219	CULVERT REPLACEMENTS @ DOUGLAS DRIVE
29	37	M34.3-R-5/220	CULVERT REPLACEMENTS @ DOUGLAS DRIVE DETAILS
31	38	M34.3-R-5/221	EDGEWOOD EMBANKMENT GENERAL PLAN AND PROFILE
31	39	M34.3-R-5/222	EDGEWOOD EMBANKMENT EMBANKMENT DETAILS
31A & 32	40	M34.3-R-5/223	EDGEWOOD STORAGE AREA EXCAVATION
31A	41	M34.3-R-5/224	EDGEWOOD STORAGE AREA UTILITIES
33	42*	M34.3-R-5/226	CULVERT REPLACEMENT @ GEORGIA AVE
34	43*	M34.3-R-5/227	CULVERT REPLACEMENT @ 36TH AVE
35	44	M34.3-R-5/228	MARKWOOD AREA CHANNEL IMPROVEMENTS

LEGEND

NUMBER OF SHEET ON WHICH CONDITION SHOWN

9 / 9 43

DETAIL OR SECTION IDENTIFICATION NUMBER

NUMBER OF SHEET ON WHICH DETAIL OR SECTION OF THE CONDITION IS DRAWN

SAFETY PAYS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

L A R
P W
L A R

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

TITLE AND INDEX

SUBMITTED BY:

APPROVED

DATE AUGUST 1982

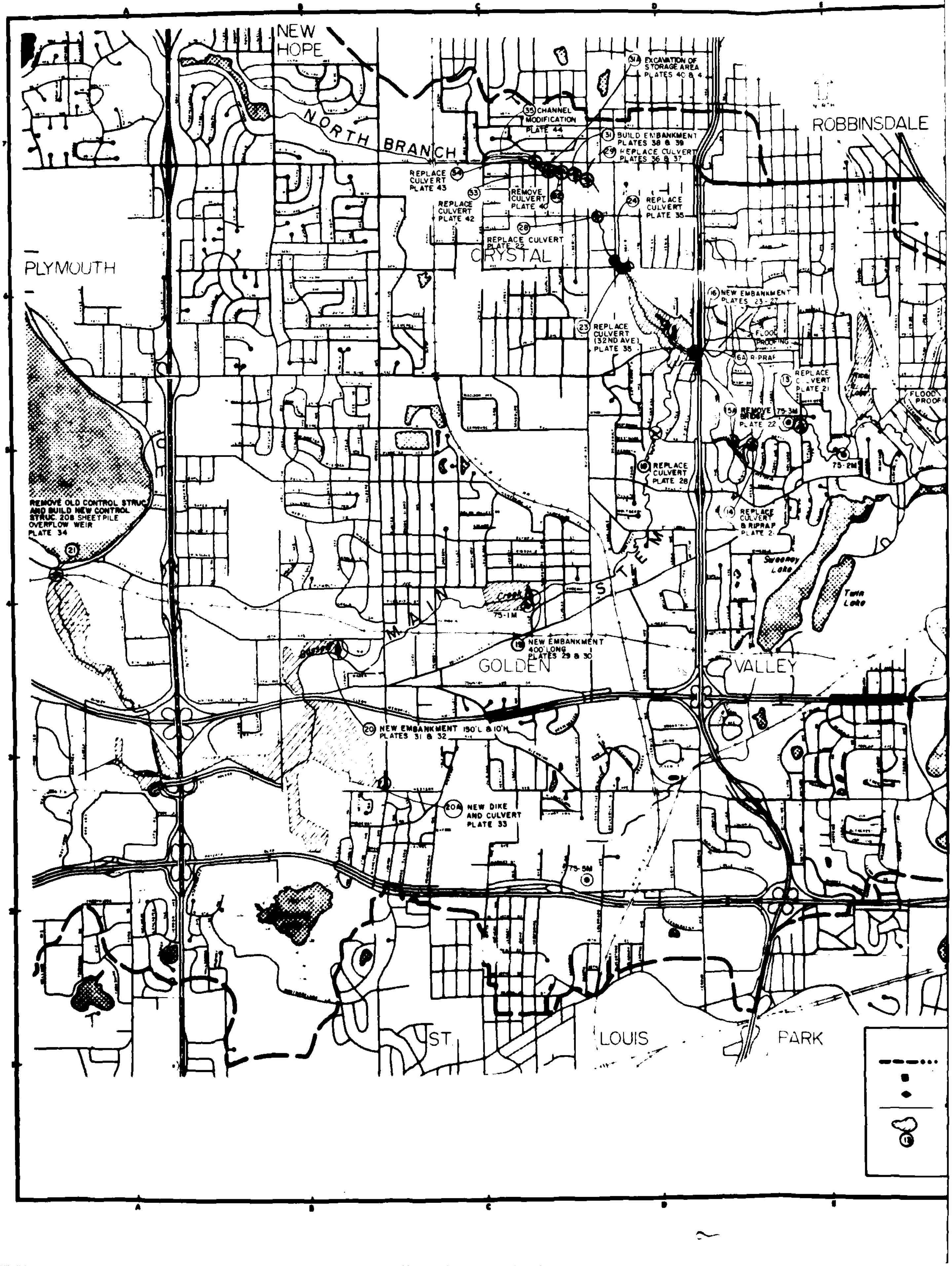
APPROVED:

DRAWING NUMBER M34.3-R-5/180

SHEET 1 OF 44

2

PLATE I



NEW HOPE
NORTH BRANCH
ROBBINSDALE
PLYMOUTH
CRYSTAL
GOLDEN VALLEY
MAIN STEM
ST LOUIS PARK
31A EXCAVATION OF STORAGE AREA PLATES 40 & 41
35 CHANNEL MODIFICATION PLATE 44
31 BUILD EMBANKMENT PLATES 38 & 39
29 REPLACE CULVERT PLATES 36 & 37
34 REPLACE CULVERT PLATE 43
33 REPLACE CULVERT PLATE 42
REMOVE CULVERT PLATE 40
24 REPLACE CULVERT PLATE 35
28 REPLACE CULVERT PLATE 22
23 REPLACE CULVERT (32ND AVE) PLATE 35
16 NEW EMBANKMENT PLATES 23-27
FLOOD PROOFING
6A RIPRAP
13 REPLACE CULVERT PLATE 21
15A REMOVE BRIDGE PLATE 22
75-3M
75-2M
18 REPLACE CULVERT PLATE 28
14 REPLACE CULVERT & RIPRAP
Sweeney Lake
Twin Lake
REMOVE OLD CONTROL STRUC. AND BUILD NEW CONTROL STRUC. 208 SHEETPILE OVERFLOW WEIR PLATE 34
21
Creek
75-1M
19 NEW EMBANKMENT 400' LONG PLATES 29 & 30
20 NEW EMBANKMENT 150'L & 10'H PLATES 31 & 32
20A NEW DIKE AND CULVERT PLATE 33
75-5M
A
B
C
D
E

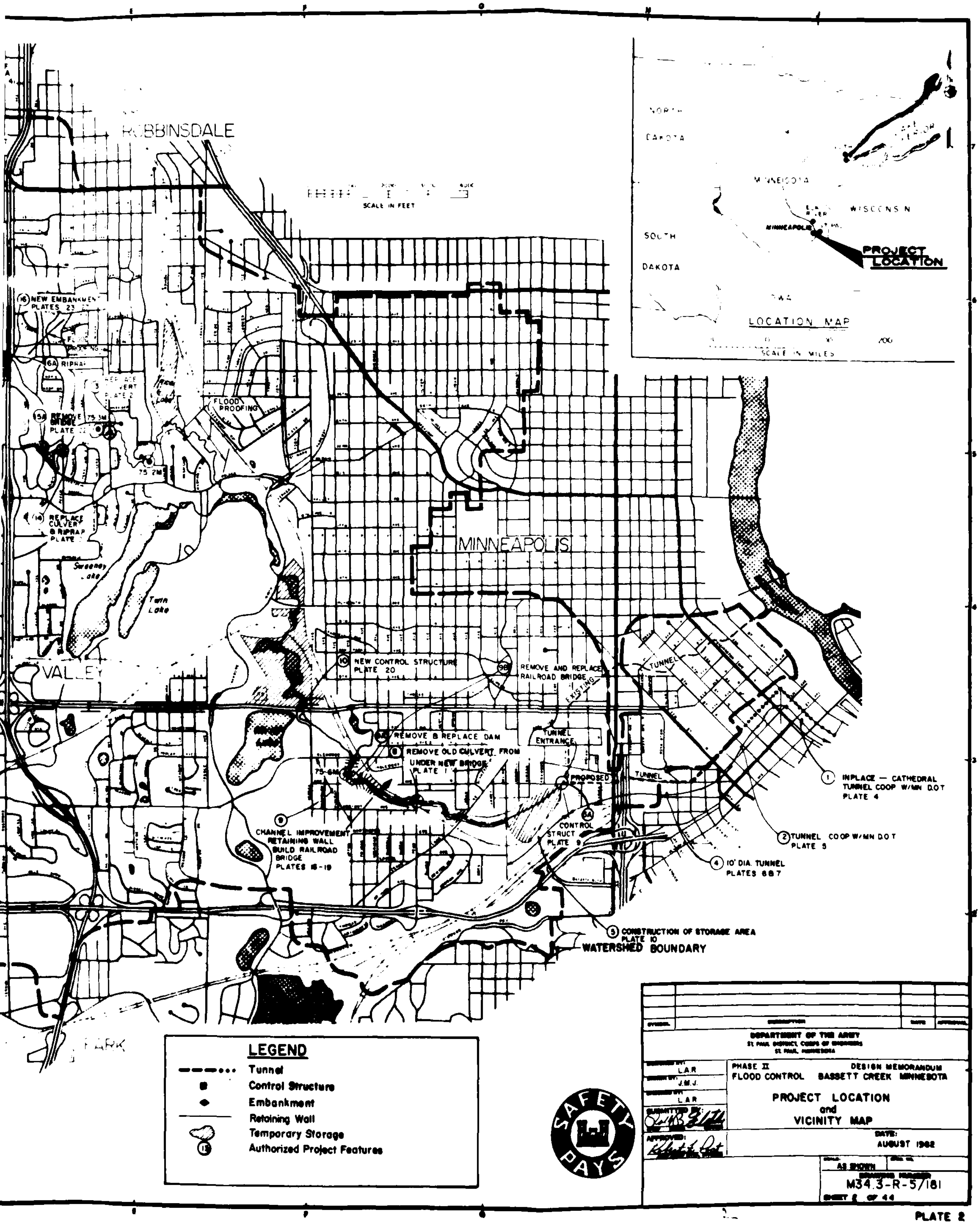
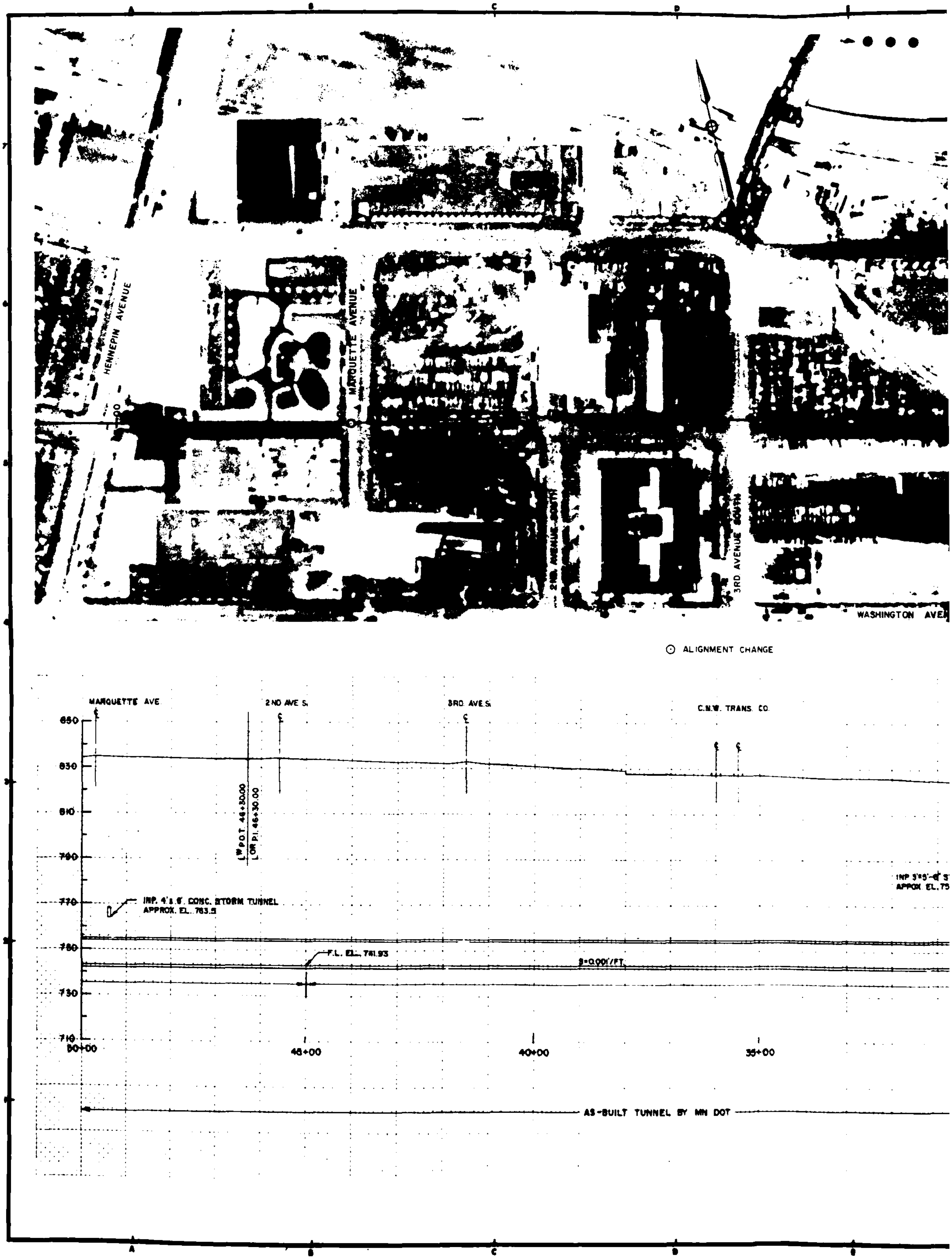
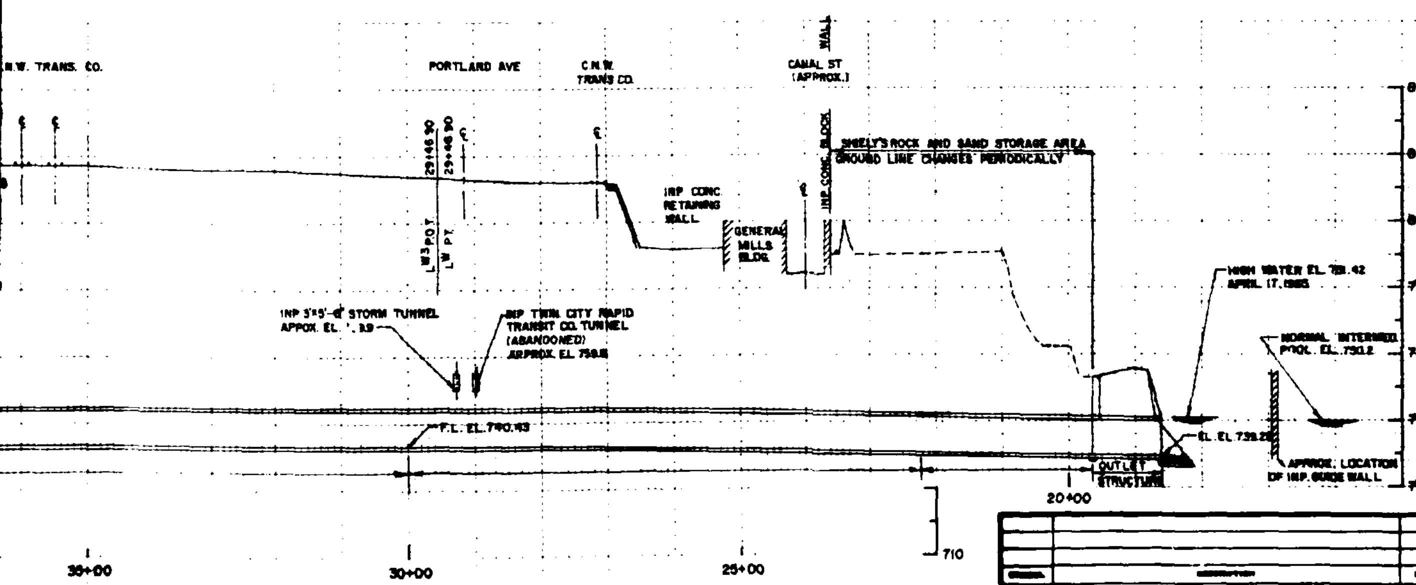

ROBBINSDALE
SCALE IN FEET
NORTH
DAKOTA
MINNESOTA
WISCONSIN
SOUTH
DAKOTA
MINNEAPOLIS
PROJECT LOCATION
LOCATION MAP
SCALE IN MILES
16 NEW EMBANKMENT PLATES 23
6A RIPRAP
15A REMOVE BRIDGE PLATE 22
75.3M
75.2M
FLOOD PROOFING
REPLACE CULVERT & RIPRAP PLATE
Sweeney Lake
Twin Lake
MINNEAPOLIS
VALLEY
10 NEW CONTROL STRUCTURE PLATE 20
9B REMOVE AND REPLACE RAILROAD BRIDGE
EXISTING
TUNNEL
8A REMOVE & REPLACE DAM
8 REMOVE OLD CULVERT FROM UNDER NEW BRIDGE PLATE 1
TUNNEL ENTRANCE
75.6M
PROPOSED
TUNNEL
9 CHANNEL IMPROVEMENT RETAINING WALL BUILD RAILROAD BRIDGE PLATES 15-19
CONTROL STRUCT PLATE 9
1 INPLACE — CATHEDRAL TUNNEL COOP W/MN DOT PLATE 4
2 TUNNEL COOP W/MN DOT PLATE 5
4 10' DIA. TUNNEL PLATES 6&7
5 CONSTRUCTION OF STORAGE AREA PLATE 10
WATERSHED BOUNDARY
PARK
LEGEND
Tunnel
Control Structure
Embankment
Retaining Wall
Temporary Storage
Authorized Project Features
SAFETY PAYS
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
L.A.R.
J.M.J.
L.A.R.
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
PROJECT LOCATION and VICINITY MAP
DATE: AUGUST 1982
AS SHOWN
M34.3-R-5/181
SHEET 2 OF 44

PLATE 2


HENNEPIN AVENUE
MARQUETTE AVENUE
2ND AVENUE SOUTH
3RD AVENUE SOUTH
WASHINGTON AVE
ALIGNMENT CHANGE
MARQUETTE AVE
2ND AVE S.
3RD AVE S.
C.N.W. TRANS. CO.
INP. 4'x6' CONC. STORM TUNNEL
APPROX. EL. 763.5
F.L. EL. 741.93
S=0.001'/FT.
790
770
750
730
710
50+00
45+00
40+00
35+00
AS-BUILT TUNNEL BY MN DOT

PHOTOGRAPH NOT TO SCALE



DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

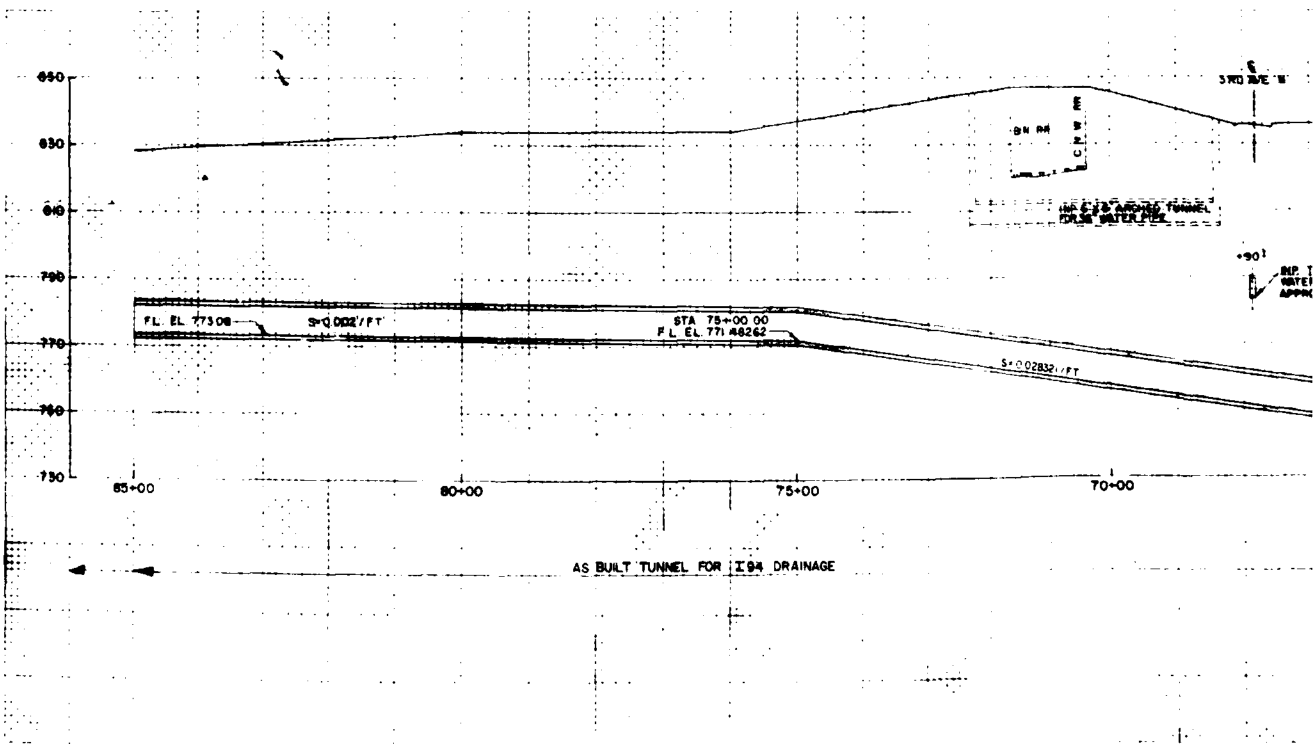
MN. DOT
J.M.J.
L A R

PHASE II — DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

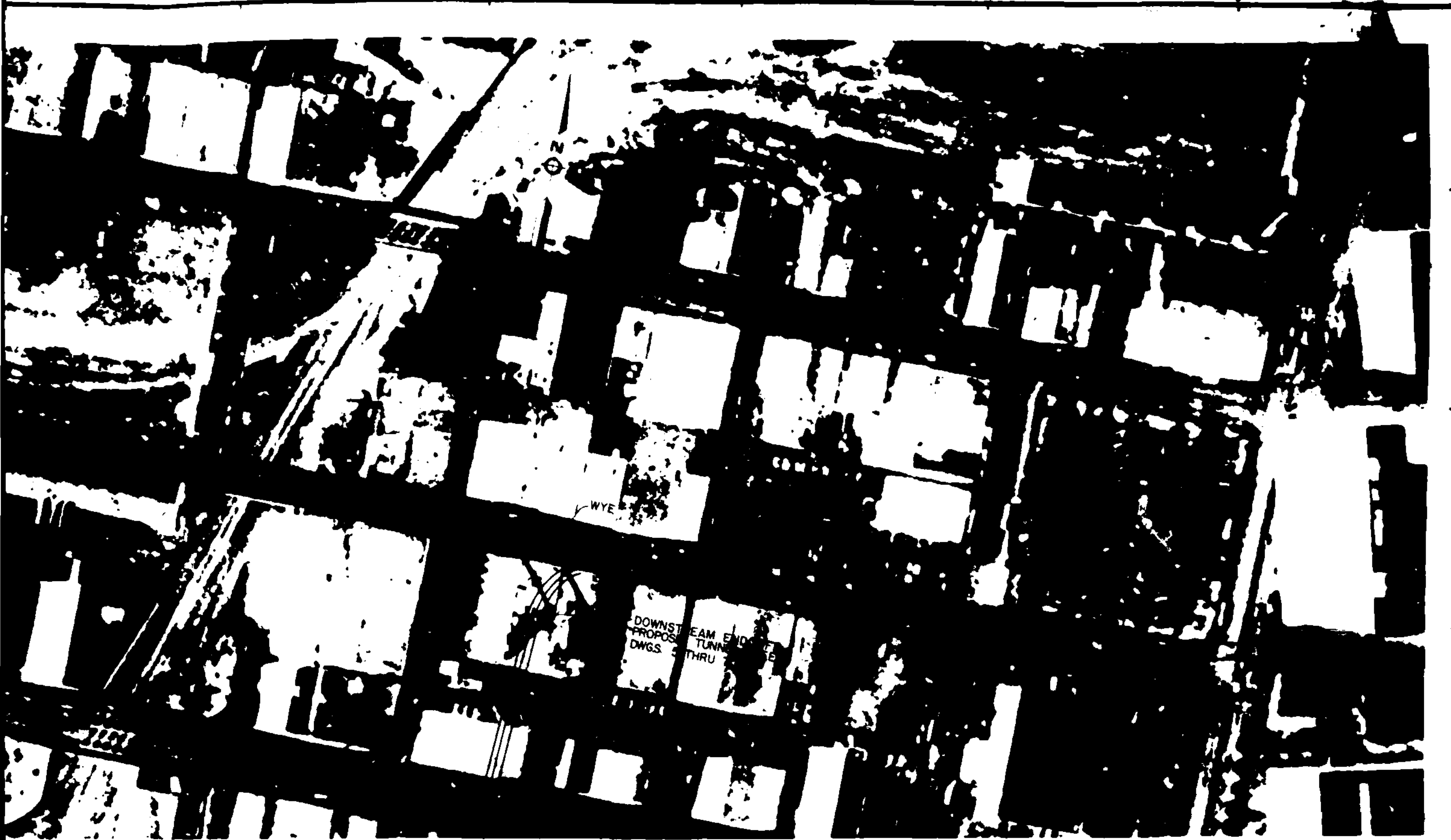
MN. D.O.T. TUNNEL PLAN AND PROFILE
STA 15+00 TO 60+00

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER M34.3-R-5/182
SHEET 3 OF 44

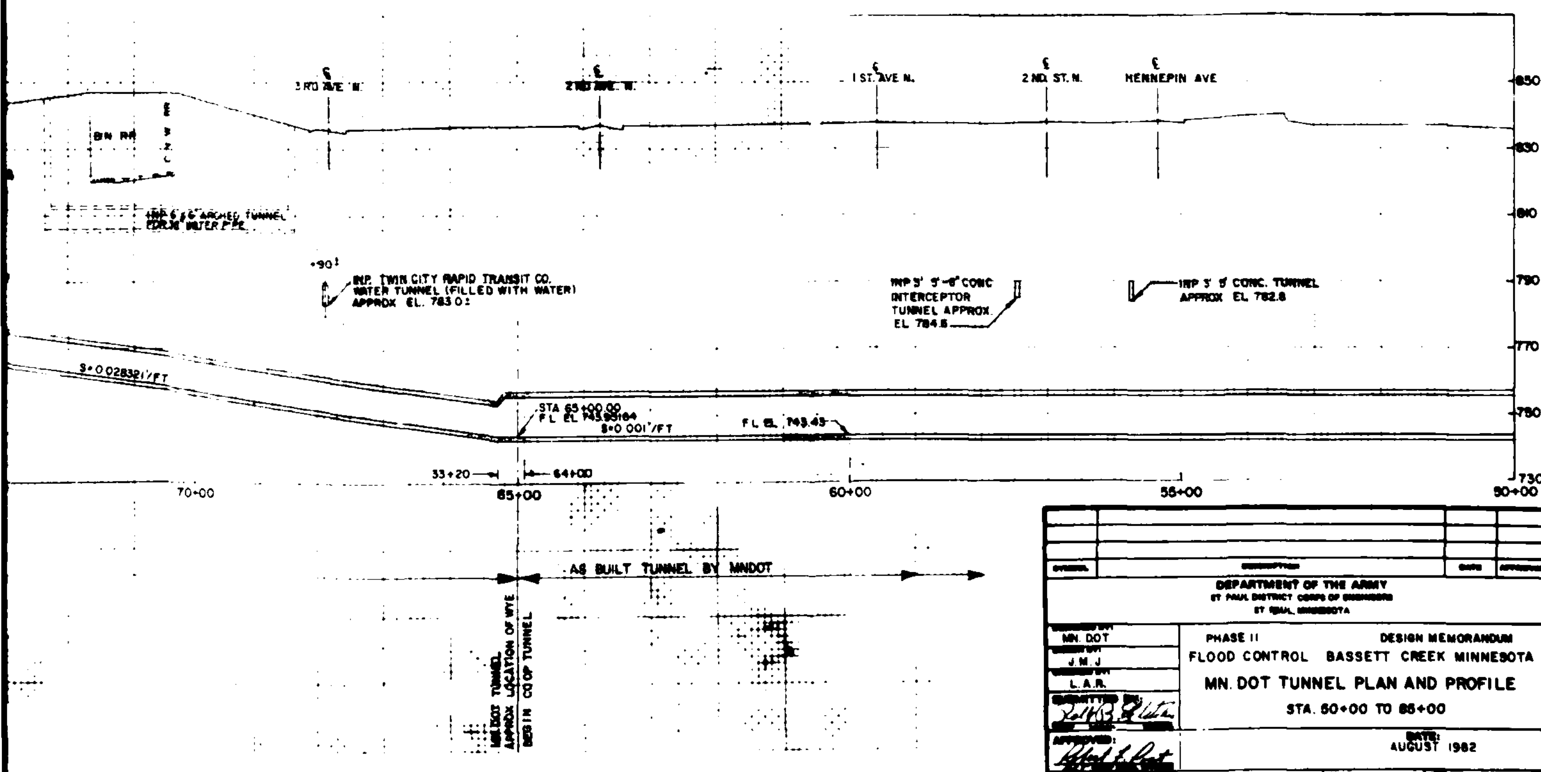
PLATE 3



850
830
810
790
770
750
FL. EL. 773.08
S=0.002'/FT
STA. 75+00.00
F.L. EL. 771.48262
S=0.02832'/FT
85+00
80+00
75+00
70+00
AS BUILT TUNNEL FOR I94 DRAINAGE



PHOTOGRAPH NOT TO SCALE



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

MN. DOT
J.M.J
L.A.R.

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
MN. DOT TUNNEL PLAN AND PROFILE
STA. 50+00 TO 65+00

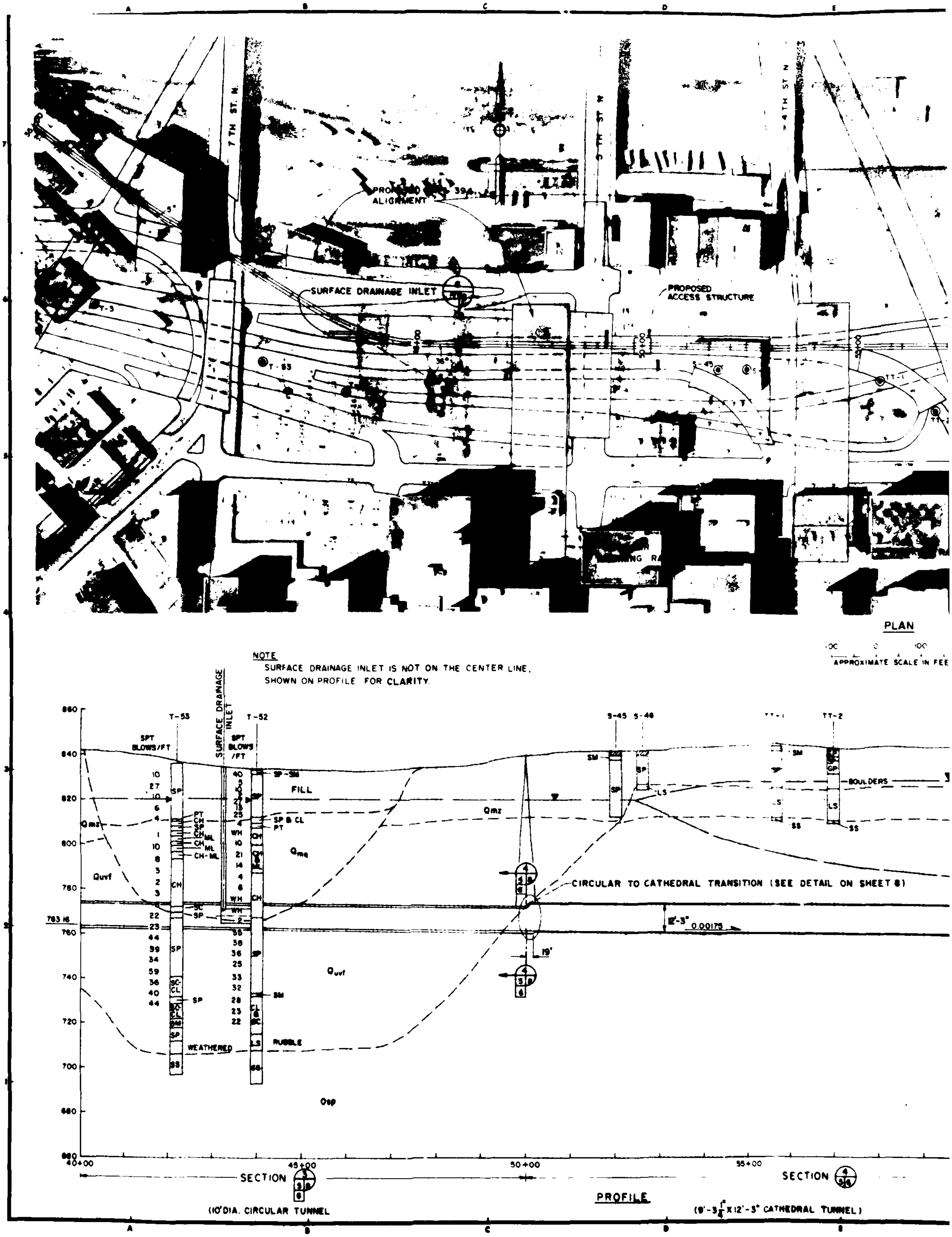
DATE: AUGUST 1982

AS SHOWN

M34 3-R-5/183

SHEET 4 OF 44

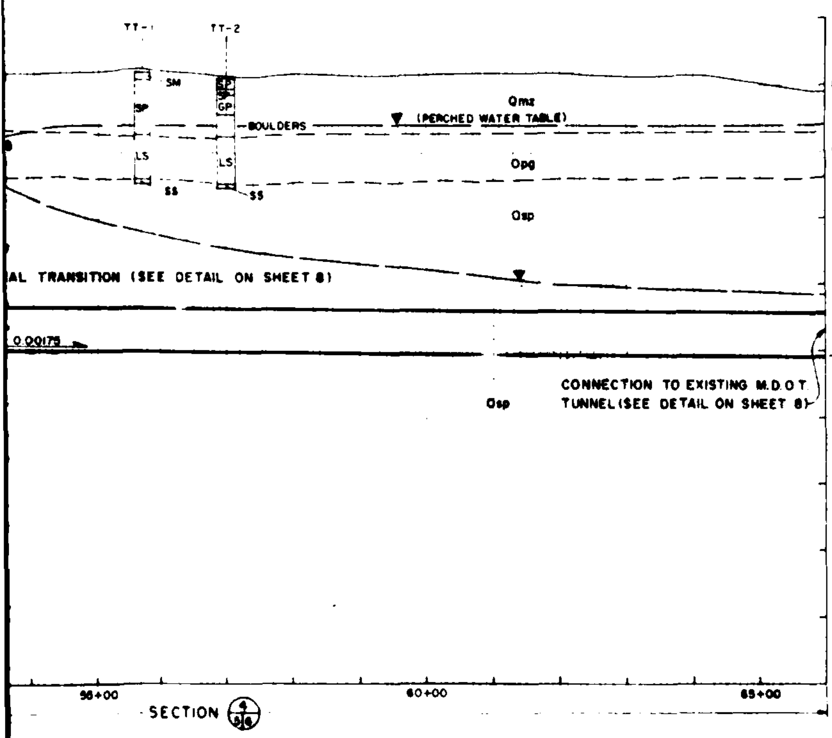
PLATE 4



7 TH ST. N.
5 TH ST N
4TH ST N
PROPOSED SR 394 ALIGNMENT
SURFACE DRAINAGE INLET
PROPOSED ACCESS STRUCTURE
T-3
T-53
S-45
TT-1
PLAN
APPROXIMATE SCALE IN FEET
NOTE
SURFACE DRAINAGE INLET IS NOT ON THE CENTER LINE, SHOWN ON PROFILE FOR CLARITY.
T-53
T-52
SURFACE DRAINAGE INLET
SPT BLOWS/FT
S-45
S-46
TT-2
FILL
Qmz
Qmq
Quvf
Qsp
WEATHERED
RUBBLE
BOULDERS
CIRCULAR TO CATHEDRAL TRANSITION (SEE DETAIL ON SHEET 8)
12'-3"
0.00175
19'
763.16
40+00
45+00
50+00
55+00
SECTION
PROFILE
(10'DIA. CIRCULAR TUNNEL
(9'-3 1/4" X 12'-3" CATHEDRAL TUNNEL)

PLAN

100 0 100 200
APPROXIMATE SCALE IN FEET



SECTION

(9'-3¾" X 12'-3" CATHEDRAL TUNNEL)

LEGEND

Qmq	FINE GRAINED LOWER TERRACE DEPOSITS
Qmz	COARSE GRAINED LOWER TERRACE DEPOSITS
Quvf	UNDIFFERENTIATED GLACIAL TILL, OUTWASH SAND AND ALLUVIUM IN BURIED BEDROCK VALLEYS
Osp	ST PETER SANDSTONE
Opg	PLATTEVILLE LIMESTONE AND GLENWOOD SHALE
▼	APPROXIMATE WATER TABLE

NOTES:

1. MATERIALS CLASSIFIED ACCORDING TO SYSTEM PRESENTED IN USGS MAP I-1157, GEOLOGIC AND HYDROLOGIC ASPECTS OF TUNNELING IN THE TWIN CITIES AREA, MINNESOTA. PLATES 2 & 5 PROJECT BORINGS SHOW FILL AT THE GROUND SURFACE AT SEVERAL LOCATIONS. FILL IS DIFFERENTIATED FROM OTHER MATERIALS BETWEEN STATIONS 40+00 & 45+00 ONLY
2. DETAILED BORING LOGS ARE SHOWN ON PLATES C-9 TO C-11

REFERENCES

1. TUNNEL PLAN & PROFILE. STA -0+25 TO STA 20+00 SHEET 7
2. TUNNEL PLAN & PROFILE STA 20+00 TO STA 40+00 SHEET 8
3. TUNNEL SECTIONS & DETAILS SHEET 8
4. LEGEND OF MATERIALS SHOWN ON THIS SHEET & ON SHEET C-11
5. THE SCALE OF PLAN VIEW IS APPROXIMATE DUE TO RELIEF DISPLACEMENT OF PHOTO

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DR RW
J.M.J.
DR
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

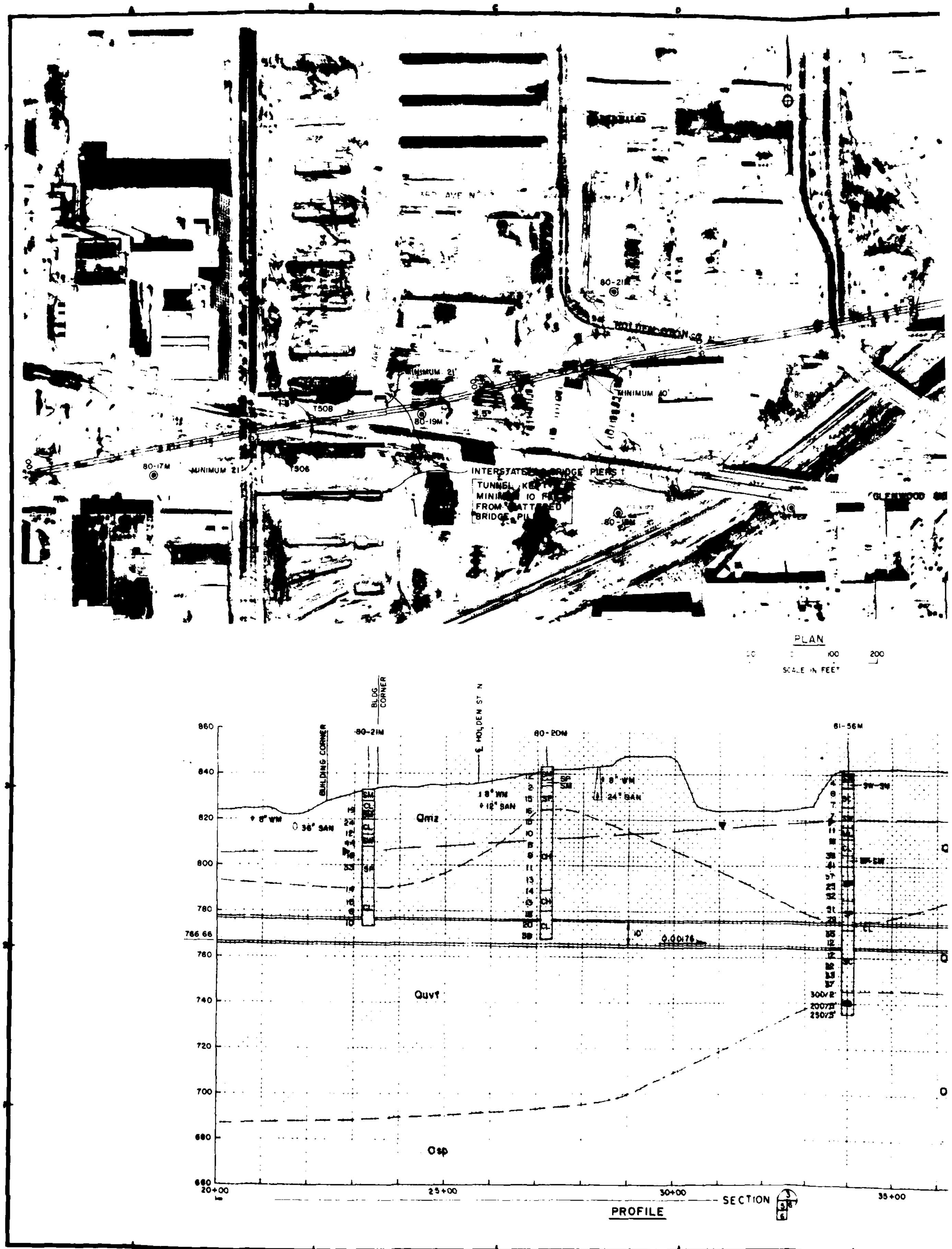
TUNNEL PLAN & PROFILE
STA 40+00 TO STA 66+50

DATE: AUGUST 1982

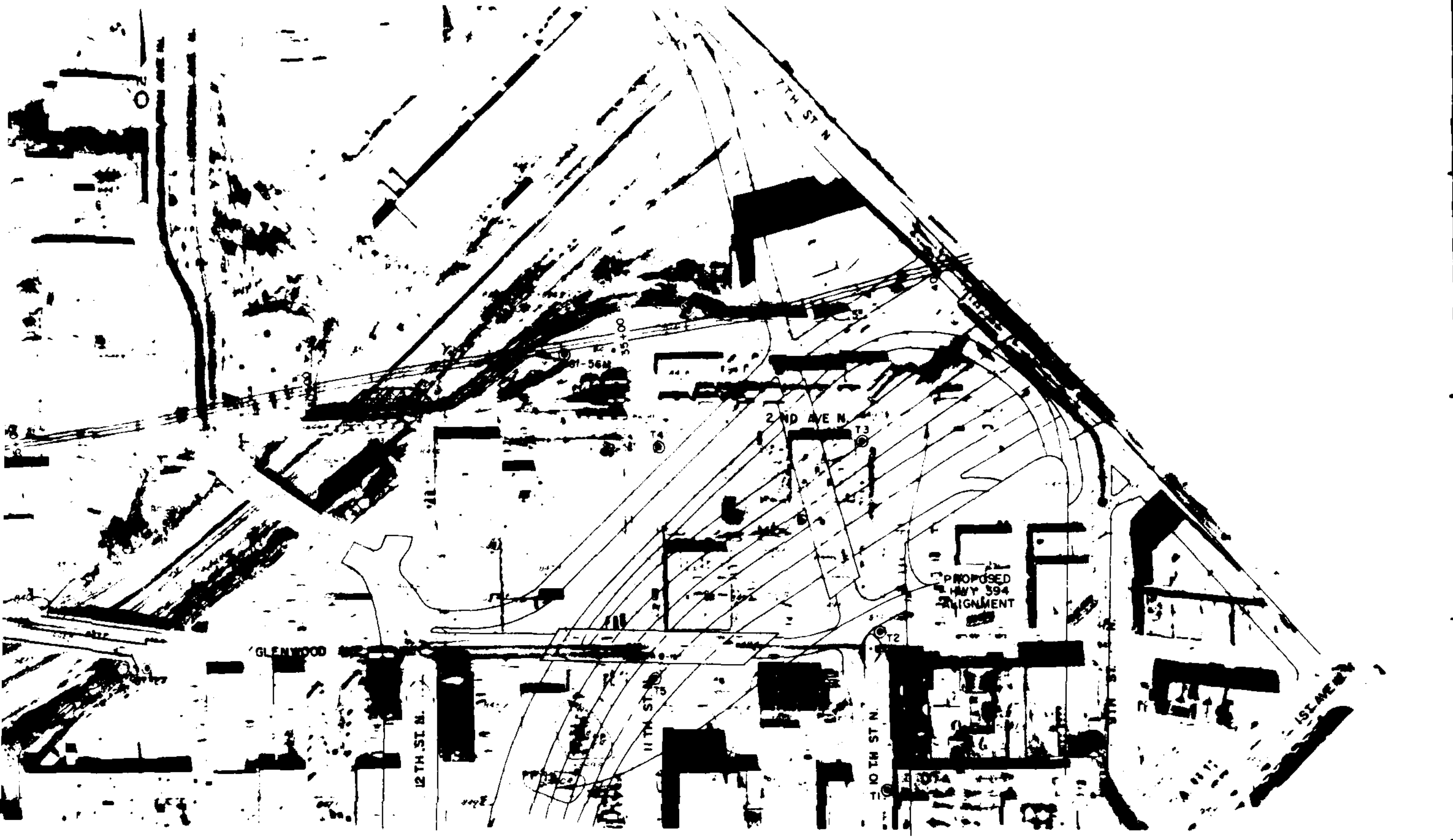
SCALE: AS SHOWN

DRAWING NUMBER M34.3-R-5/184
SHEET 3 OF 44

PLATE 8



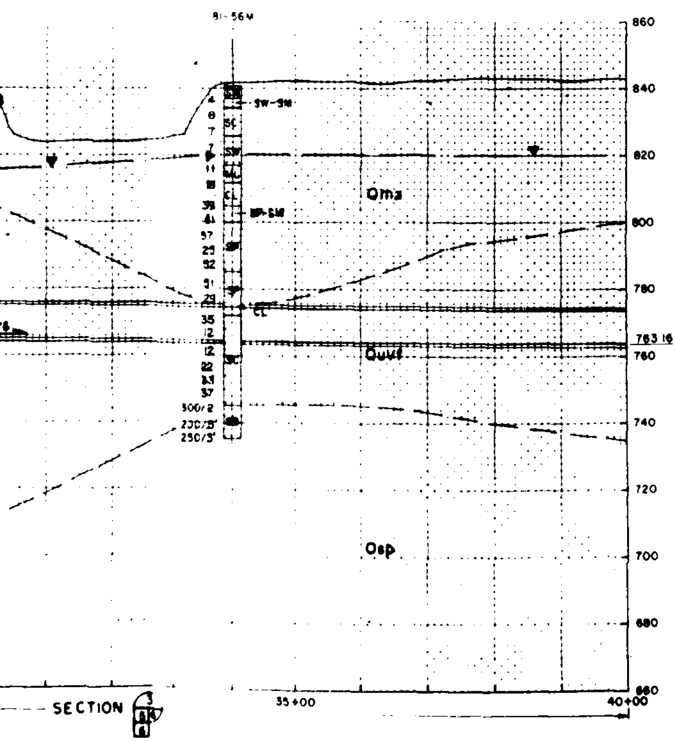
80-21M
80-19M
80-17M
MINIMUM 21'
MINIMUM 10'
T508
T506
INTERSTATE BRIDGE PIERS
GLENWOOD
PLAN
SCALE IN FEET
BUILDING CORNER
BLDG CORNER
HOLDEN ST N
80-20M
81-56M
Qmiz
Quvf
Qsp
PROFILE
SECTION



PLAN

100 0 100 200

SCALE IN FEET



LEGEND

Qmq	FINE GRAINED LOWER TERRACE DEPOSITS
Qmz	COARSE GRAINED LOWER TERRACE DEPOSITS
Quvf	UNDIFFERENTIATED GLACIAL TILL, OUTWASH SAND AND ALLUVIUM IN BURIED BEDROCK VALLEYS
Osp	ST PETER SANDSTONE
Opq	PLATTEVILLE LIMESTONE AND GLENWOOD SHALE
—▼—	APPROXIMATE WATER TABLE

NOTES:

1. MATERIALS CLASSIFIED ACCORDING TO SYSTEM PRESENTED IN U.S.G.S. MAP I-1157, GEOLOGIC AND HYDROLOGIC ASPECTS OF TUNNELING IN THE TWIN CITIES AREA, MINNESOTA, PLATES 2 & 5. PROJECT BORINGS SHOW FILL AT THE GROUND SURFACE AT SEVERAL LOCATIONS. FILL IS DIFFERENTIATED FROM OTHER MATERIALS BETWEEN STATIONS 40+00 & 45+00 ONLY
2. DETAILED BORING LOGS ARE SHOWN ON PLATES C-9 TO C-11

REFERENCES

1. TUNNEL PLAN & PROFILE STA. 0-25 TO STA 20+00 ------ SHEET 7
2. TUNNEL PLAN & PROFILE STA. 40+00 TO STA. 66+50 ----- SHEET 5
3. TUNNEL SECTIONS & DETAILS ---------------- SHEET 8
4. LEGEND OF MATERIALS SHOWN ON SHEET. C-11

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

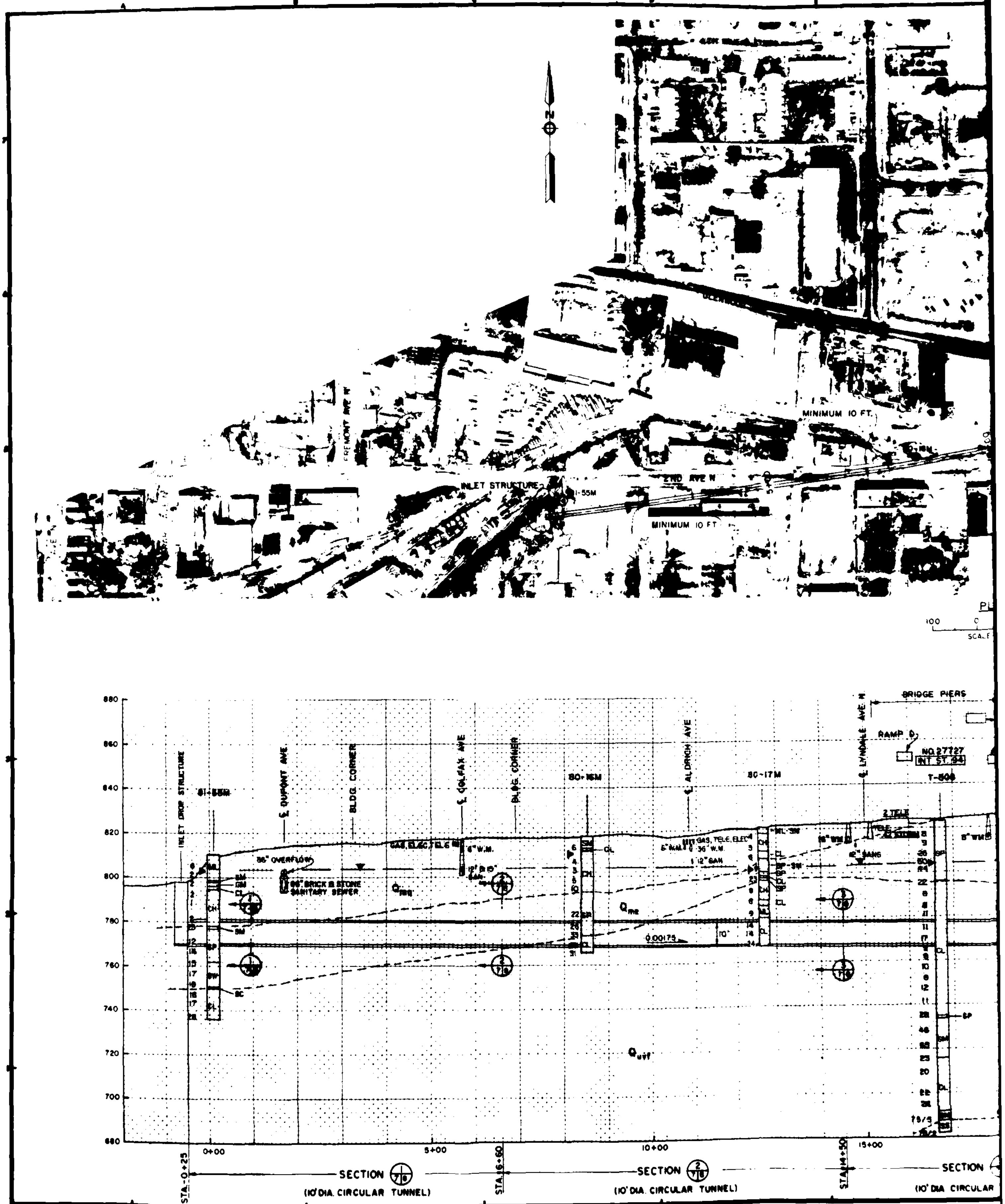
P.W.O.W.R	PHASE II DESIGN MEMORANDUM
J.G.J., J.M.J	FLOOD CONTROL BASSETT CREEK MINNESOTA
DWR	TUNNEL PLAN & PROFILE STA. 20+00 TO 40+0C
SUBMITTED BY:	
APPROVED:	DATE: AUGUST 1982

SCALE: AS SHOWN

DRAWING NUMBER M34.3-R-5/185

SHEET 6 OF 44

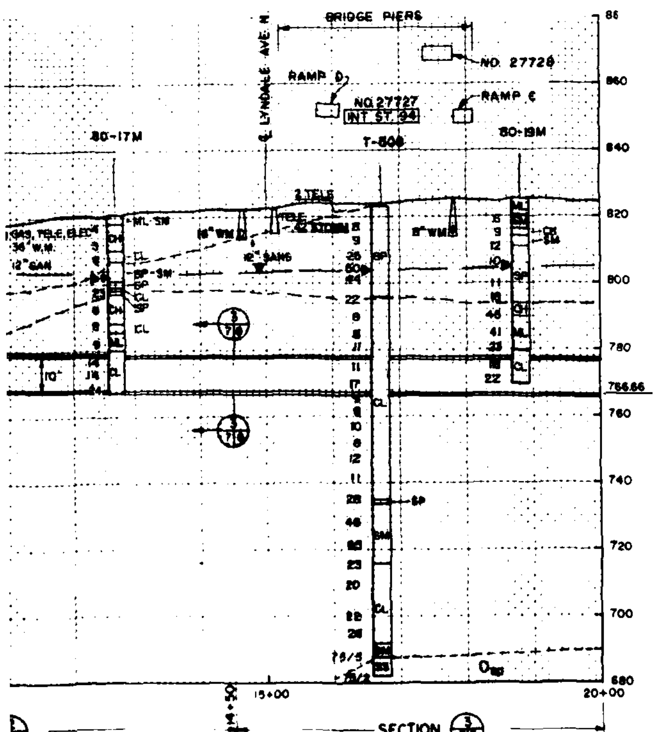
PLATE 6



MINIMUM 10 FT.
FREMONT AVE N
INLET STRUCTURE
31-55M
2ND AVE N
MINIMUM 10 FT.
100
SCALE
880
860
840
820
800
780
760
740
720
700
680
INLET DROP STRUCTURE
31-55M
℄ DUPONT AVE.
BLDG. CORNER
℄ COLFAX AVE
BLDG. CORNER
80-16M
℄ ALDRICH AVE
80-17M
℄ LYNDALE AVE. N
BRIDGE PIERS
RAMP D
NO. 27727
INT. ST. 94
T-506
36" OVERFLOW
66" BRICK & STONE SANITARY SEWER
GAS, ELEC, TELE, ELEC
6" W.M.
GAS, TELE, ELEC
6" MAIN
36" W.M.
12" SAN
2 TELE
16" WM
12" SANS
8" WM
0.00175
Q_{uvf}
0+00
5+00
10+00
15+00
STA.-0+25
STA.6+60
STA.14+50
SECTION 1/7B
(10' DIA. CIRCULAR TUNNEL)
SECTION 2/7B
(10' DIA. CIRCULAR TUNNEL)
SECTION
(10' DIA. CIRCULAR

PLAN

100 0 100 200
SCALE IN FEET



SECTION 3/7B

(10' DIA. CIRCULAR TUNNEL)

LEGEND

Qmq	FINE GRAINED LOWER TERRACE DEPOSITS
Qmz	COARSE GRAINED LOWER TERRACE DEPOSITS
Quvf	UNDIFFERENTIATED GLACIAL TILL, OUTWASH SAND AND ALLUVIUM IN BURIED BEDROCK VALLEYS
Osp	ST PETER SANDSTONE
Opq	PLATTEVILLE LIMESTONE AND GLENWOOD SHALE
▼	APPROXIMATE WATER TABLE

NOTES:

1. MATERIALS CLASSIFIED ACCORDING TO SYSTEM PRESENTED IN U.S.G.S. MAP I-1157, GEOLOGIC AND HYDROLOGIC ASPECTS OF TUNNELING IN THE TWIN CITIES AREA, MINNESOTA, PLATES 2 & 5. PROJECT BORINGS SHOW FILL AT THE GROUND SURFACE AT SEVERAL LOCATIONS. FILL IS DIFFERENTIATED FROM OTHER MATERIALS BETWEEN STATIONS 40+00 & 45+00 ONLY.
2. DETAILED BORING LOGS ARE SHOWN ON SHEETS C-9 TO C-11

REFERENCES	SHEET NO.
1. TUNNEL PLAN & PROFILE: STA. 20+00 TO STA. 40+00 SHEET	6
2. TUNNEL PLAN & PROFILE: STA 40+00 TO STA 66+50 SHEET	5
3. TUNNEL SECTIONS & DETAILS SHEET	8
4. LEGEND OF MATERIALS SHOWN ON SHEET	C-11
5. INLET STRUCTURE	9

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DR. RW
J.G.J., J.M.J.
D.R.
SUBMITTED BY:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

TUNNEL PLAN & PROFILE
STA 0-25 to 20+00

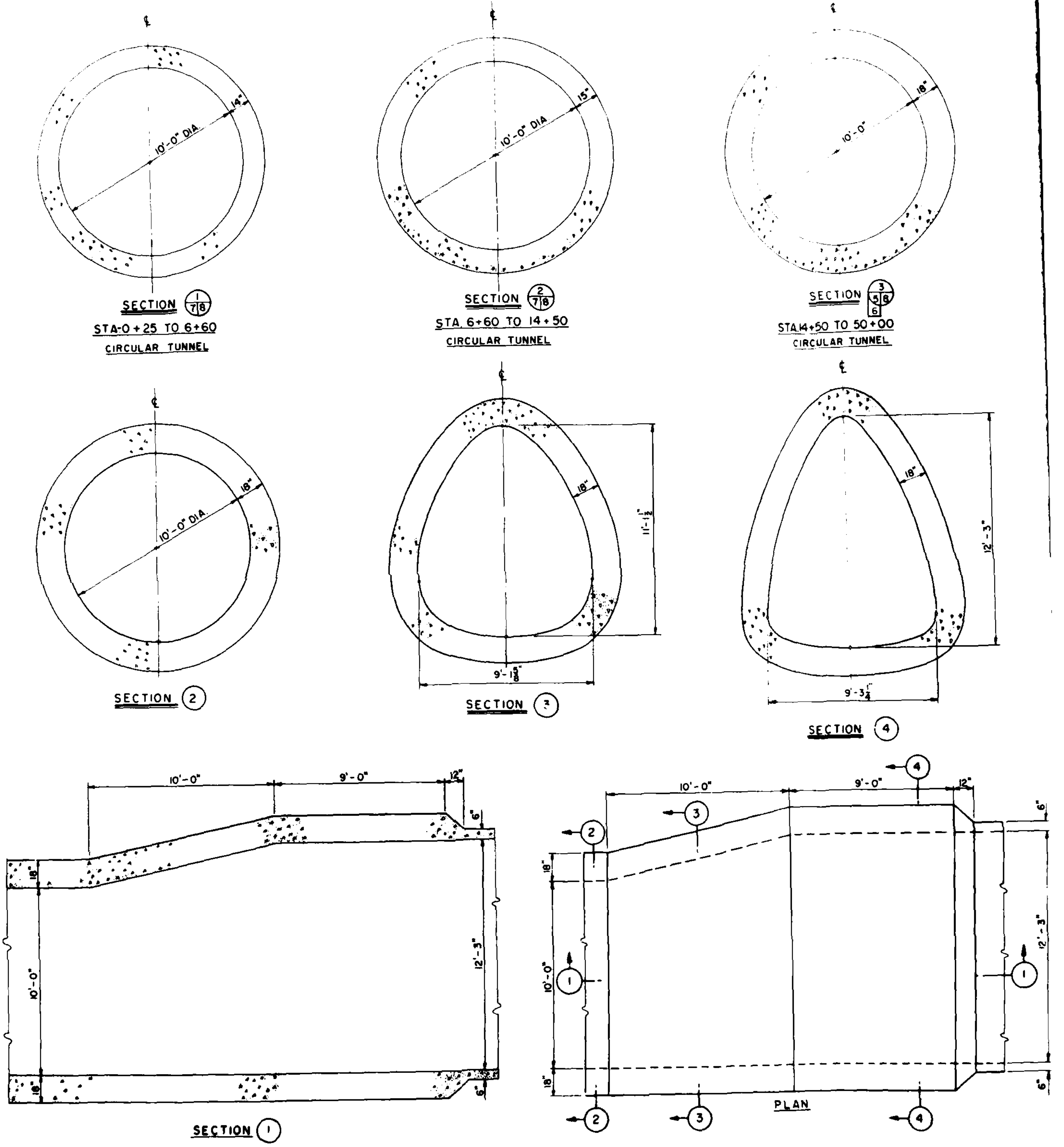
AUGUST 1962

AS SHOWN

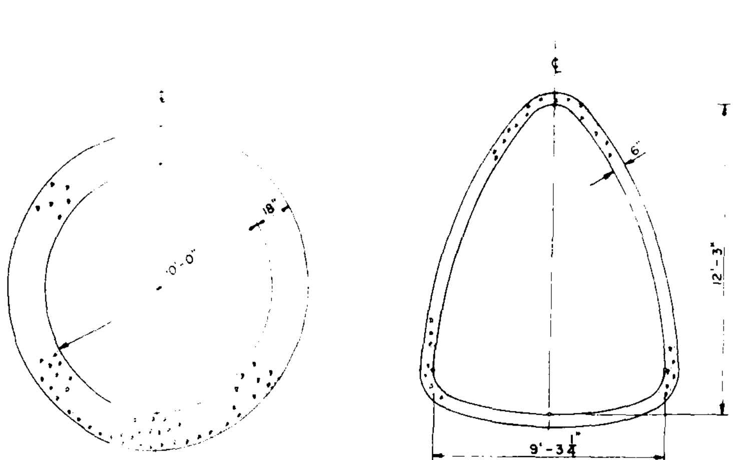
M34.3-R-5/186

SHEET 7 OF [illegible]

PLATE 7.

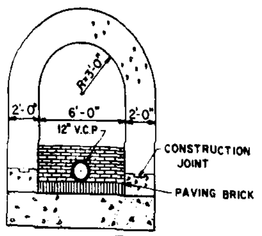


CIRCULAR TO CATHEDRAL TRANSITION

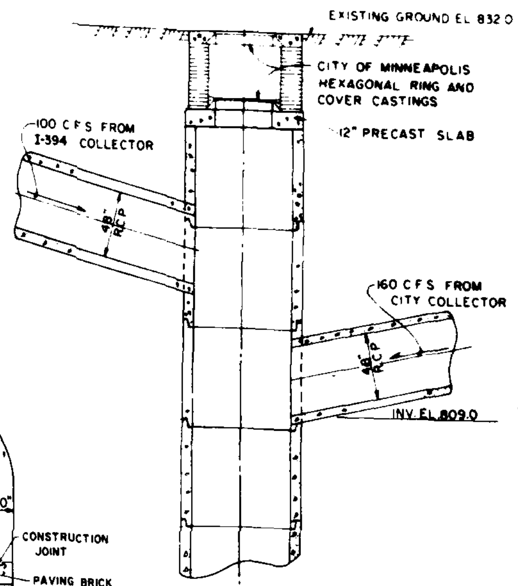


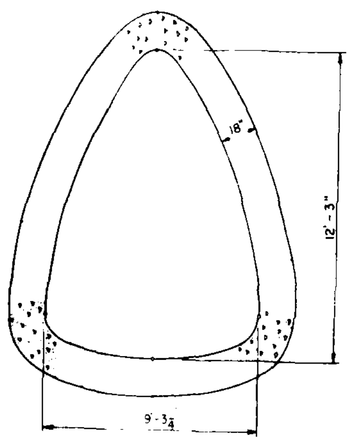
SECTION 3/5-8 (6)
STA.14+50 TO 50+00
CIRCULAR TUNNEL

SECTION 4/5-8
STA.50+00 TO 66+00
CATHEDRAL TUNNEL

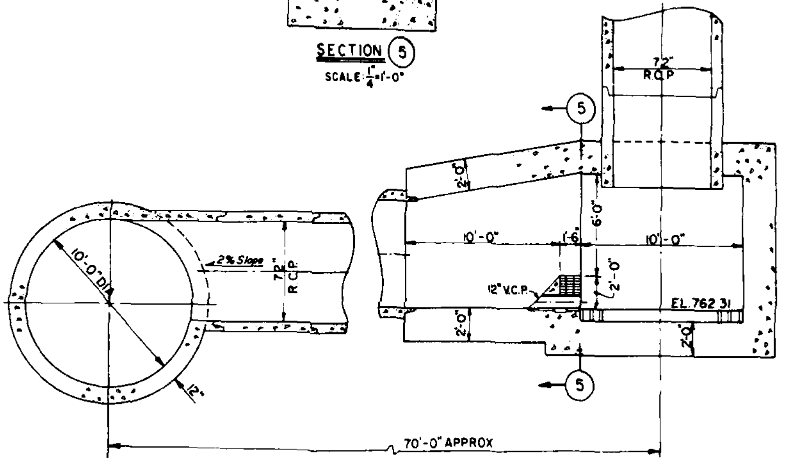


SECTION 5
SCALE: 1/4"=1'-0"



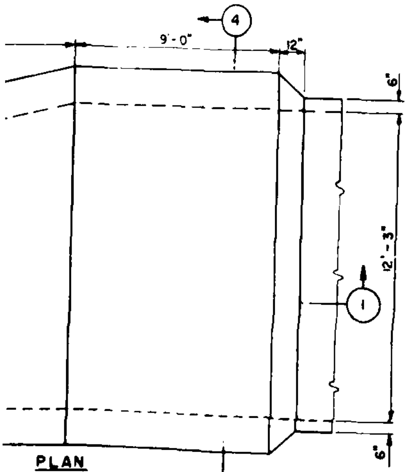


SECTION 4

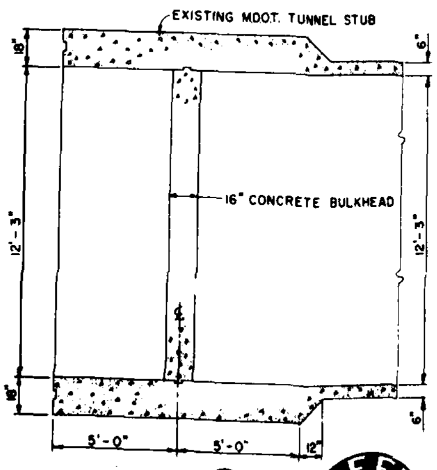


LONGITUDINAL SECTION 6/5-8
SURFACE DRAINAGE INLET
SCALE: 1/4"=1'-0"

NOTES:
1. TUNNEL LINER THICKNESSES ARE GIVEN AS A MINIMUM THICKNESS REQUIRED FOR THE SECTION.
2. DUE TO RESTRICTIONS OF TUNNELING METHOD CHOSEN A THICKNESS EQUAL TO THE MAXIMUM LINER THICKNESS REQUIRED MAY BE USED IN CONSTRUCTION OF THE TUNNEL.



PLAN



SECTION 5/5-8
STA. 66+00

0 1 2 3 4
SCALE IN FEET

SAFETY PAYS

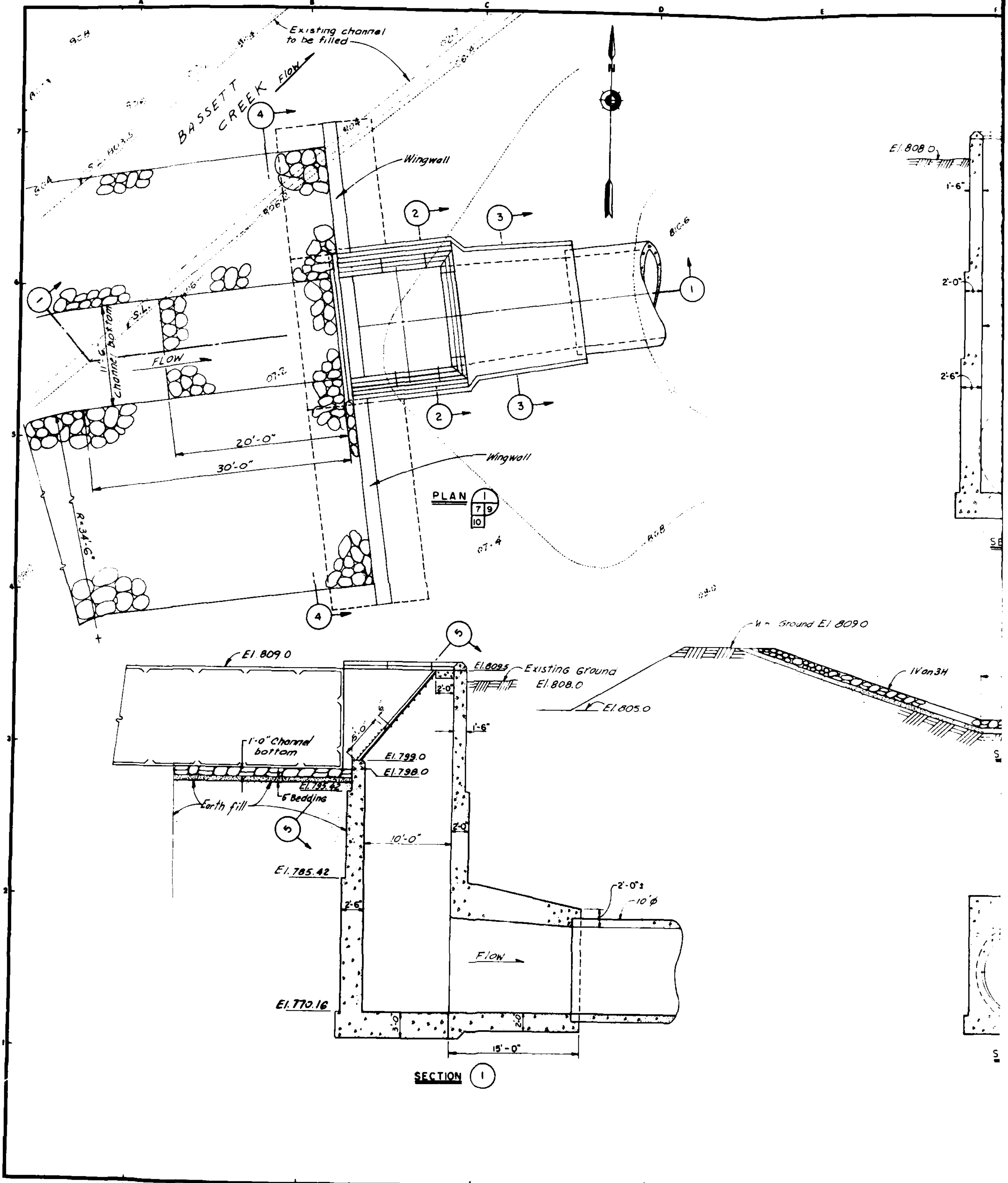
SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

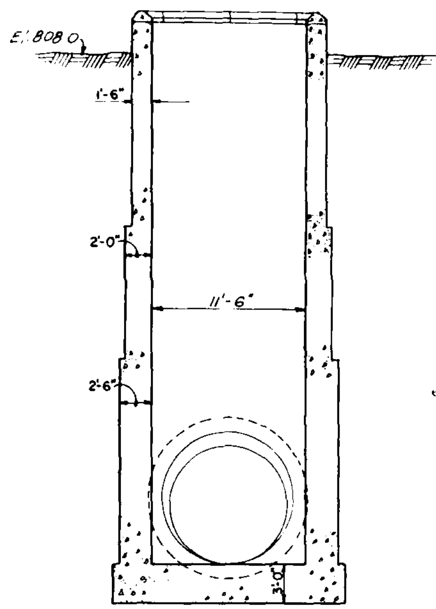
DESIGNED BY: S.P.L.	PHASE II FLOOD CONTROL — DESIGN MEMORANDUM BASSETT CREEK MINNESOTA
DRAWN BY: S.P.L.	BASSETT CREEK
SUBMITTED BY:	TUNNEL SECTIONS AND DETAILS
APPROVED:	DATE: AUGUST 1962
SCALE: AS SHOWN	DRAWING NUMBER: M34.3-R-5/187
	SHEET 8 OF 44

2

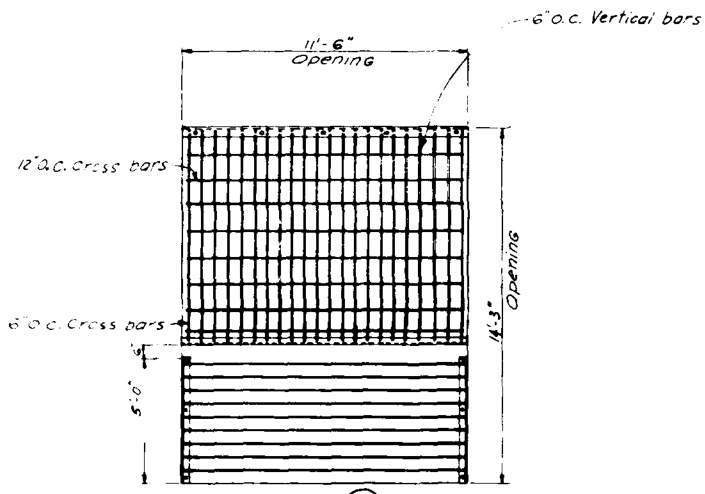
PLATE 8



Existing channel to be filled
BASSETT CREEK
FLOW
Wingwall
Channel bottom
11'-6"
20'-0"
30'-0"
R=34'-6"
PLAN
El. 809.0
El. 809.5
Existing Ground El. 808.0
2'-0"
1'-6"
1'-0" Channel bottom
El. 799.0
El. 798.0
El. 795.42
6" Bedding
Earth fill
10'-0"
El. 785.42
2'-6"
2'-0"±
10'ø
FLOW
El. 770.16
3'-0"
2'-0"
15'-0"
SECTION
Ground El. 809.0
El. 805.0
1V on 3H
El. 808.0
1'-6"
2'-0"
2'-6"



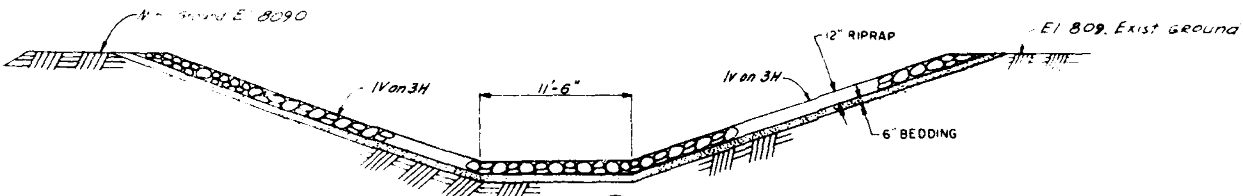
SECTION (2)



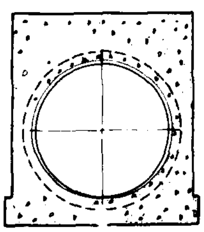
SECTION (5)

TRASH RACK DETAIL

SCALE 3/8"=1'-0"



SECTION (3)



SECTION (3)

5 4 3 2 1 0

SCALE IN FEET

DEPARTMENT OF THE ARMY

ST PAUL DISTRICT CORPS OF ENGINEERS

ST PAUL MINNESOTA

S P L

S P L

PHASE II

FLOOD CONTROL

DESIGN MEMORANDUM

BASSETT CREEK MINNESOTA

BASSETT CREEK

INLET STRUCTURE

SUBMITTED BY:

APPROVED:

DATE:

AUGUST 1982

SCALE AS SHOWN

DRAWING NUMBER

M34.3-R-5/188

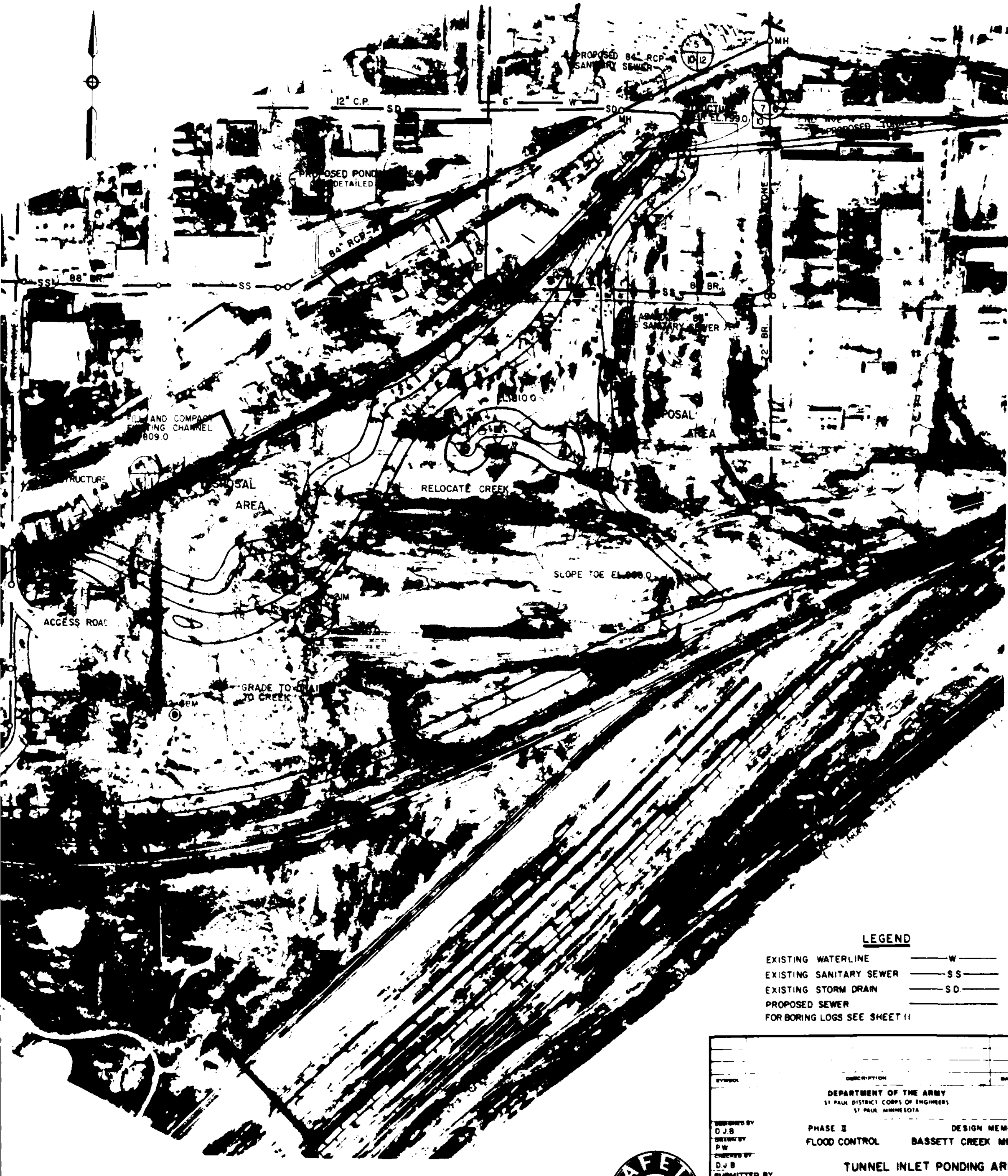
SHEET 9 OF 44

PLATE 9

NOTE ALL SIDE SLOPES ARE 1V ON 3H

PROPOSED PONDING AREA
DETAILED DRAWING

50 0 50 100
SCALE IN FEET



100 0 100 200
SCALE IN FEET

LEGEND

EXISTING WATERLINE	——W——
EXISTING SANITARY SEWER	——S.S——
EXISTING STORM DRAIN	——S.D.——
PROPOSED SEWER	————

FOR BORING LOGS SEE SHEET 11

SYMBOL DESCRIPTION DATE APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY D.J.B
DRAWN BY P.W
CHECKED BY D.J.B
SUBMITTED BY
APPROVED

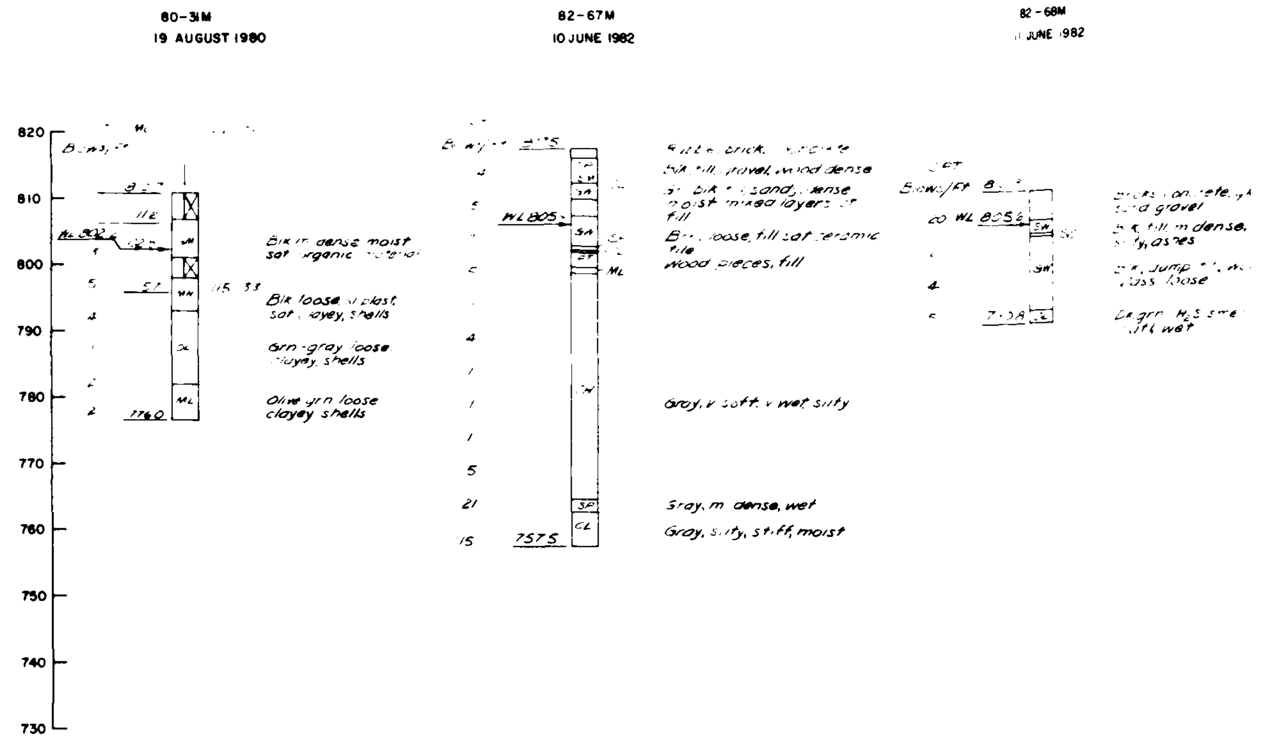
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

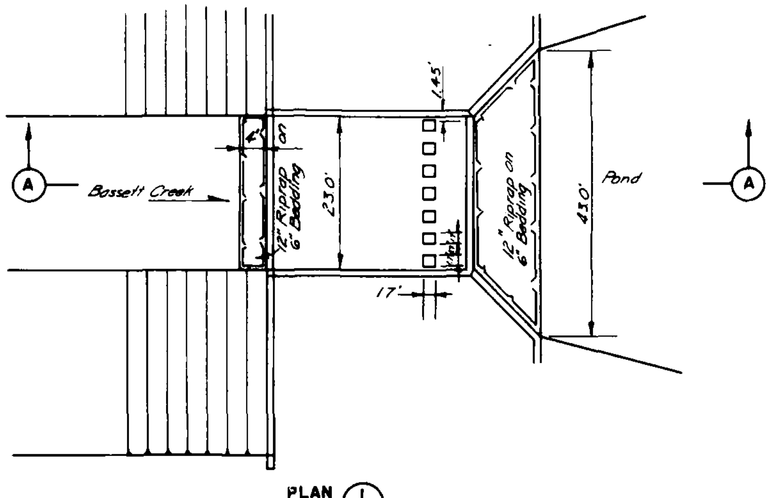
TUNNEL INLET PONDING AREA

DATE
AUGUST 1982

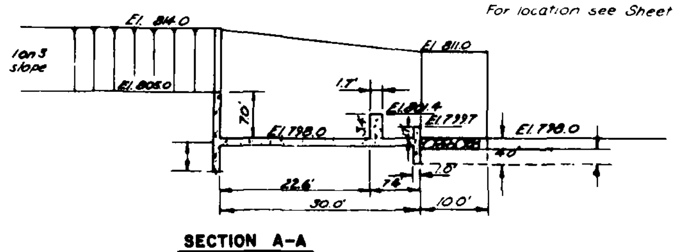
DRAWING NUMBER
M34.3-R-5/189
SHEET 10 OF 44

PLATE 10





PLAN

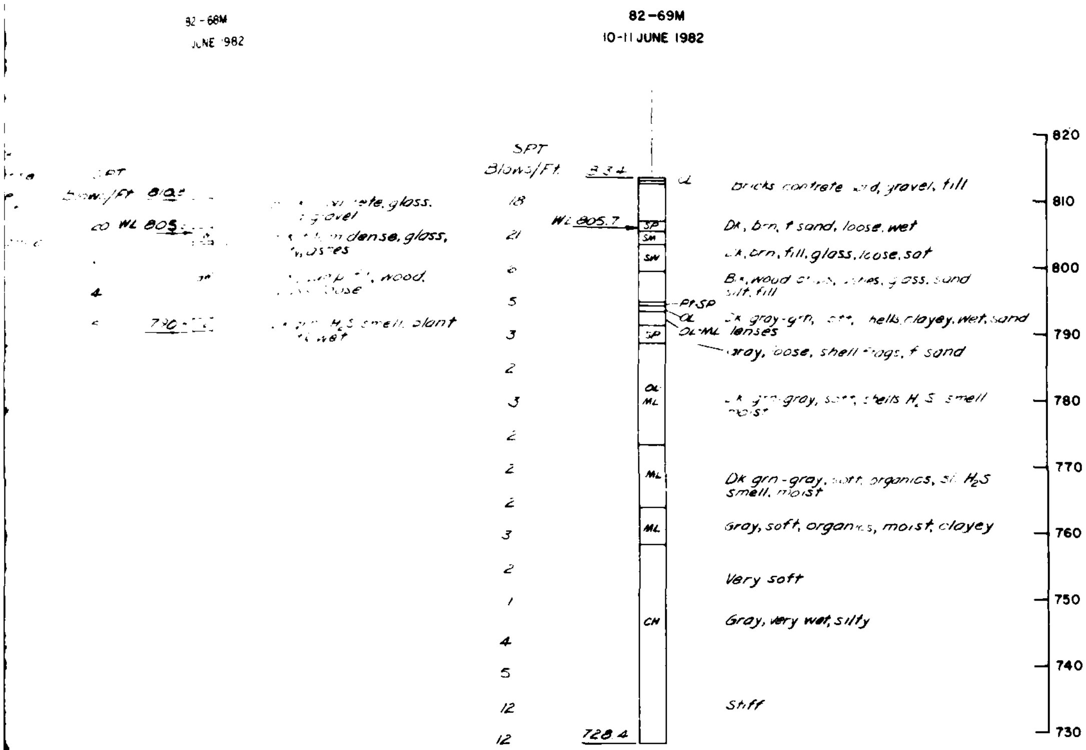


For location see Sheet 10

SECTION A-A

SCALE IN FEET

10 5 0 10 20 30



NOTE

BORING LEGEND SHOWN ON PLATE C-11

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

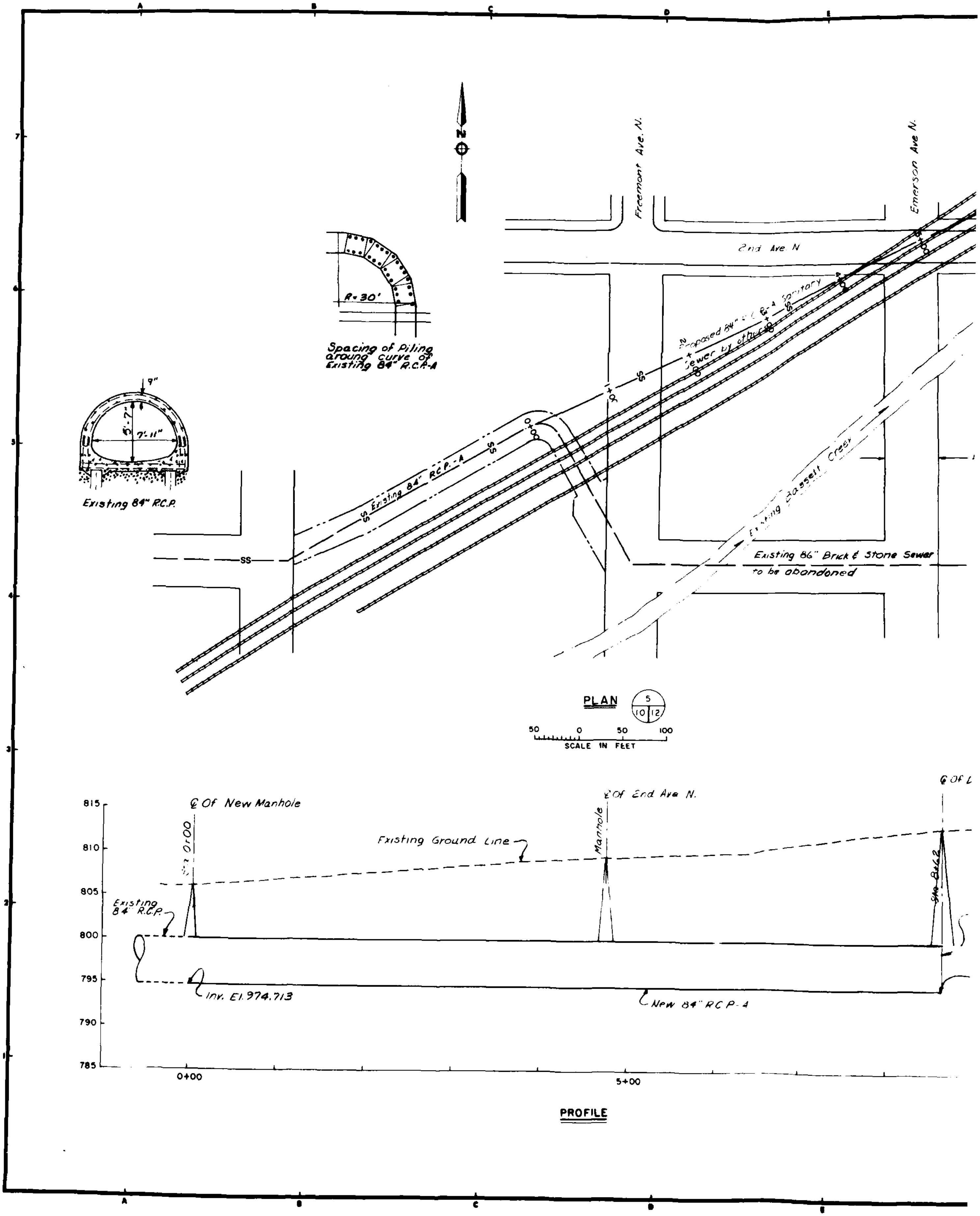
DESIGNED BY: D.R. L.A.R.
DRAWN BY: J.M.J
CHECKED BY: D.R. L.A.R.
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
TUNNEL INLET PONDING AREA
BORING LOGS AND DROP STRUCTURE
PLAN, SECTION AND DETAILS

DATE: AUGUST 1982

SCALE: AS SHOWN

DRAWING NUMBER: M34.3-R-5/190
SHEET 11 OF 44



N
Fremont Ave. N.
Emerson Ave N.
2nd Ave. N
R=30'
Spacing of Piling around curve of Existing 84" R.C.P.-A
9"
5'-7"
7'-11"
Existing 84" R.C.P.
Proposed 84" R.C.P.-A Sanitary Sewer by others
SS
Existing 84" R.C.P.-A
0+00
5+00
Existing Bassett Creek
Existing 86" Brick & Stone Sewer to be abandoned
PLAN
5
10
12
50
0
50
100
SCALE IN FEET
℄ Of New Manhole
℄ Of 2nd Ave N.
Manhole
Existing Ground Line
Existing 84" R.C.P.
Inv. El. 974.713
New 84" RCP-A
815
810
805
800
795
790
785
0+00
5+00
PROFILE

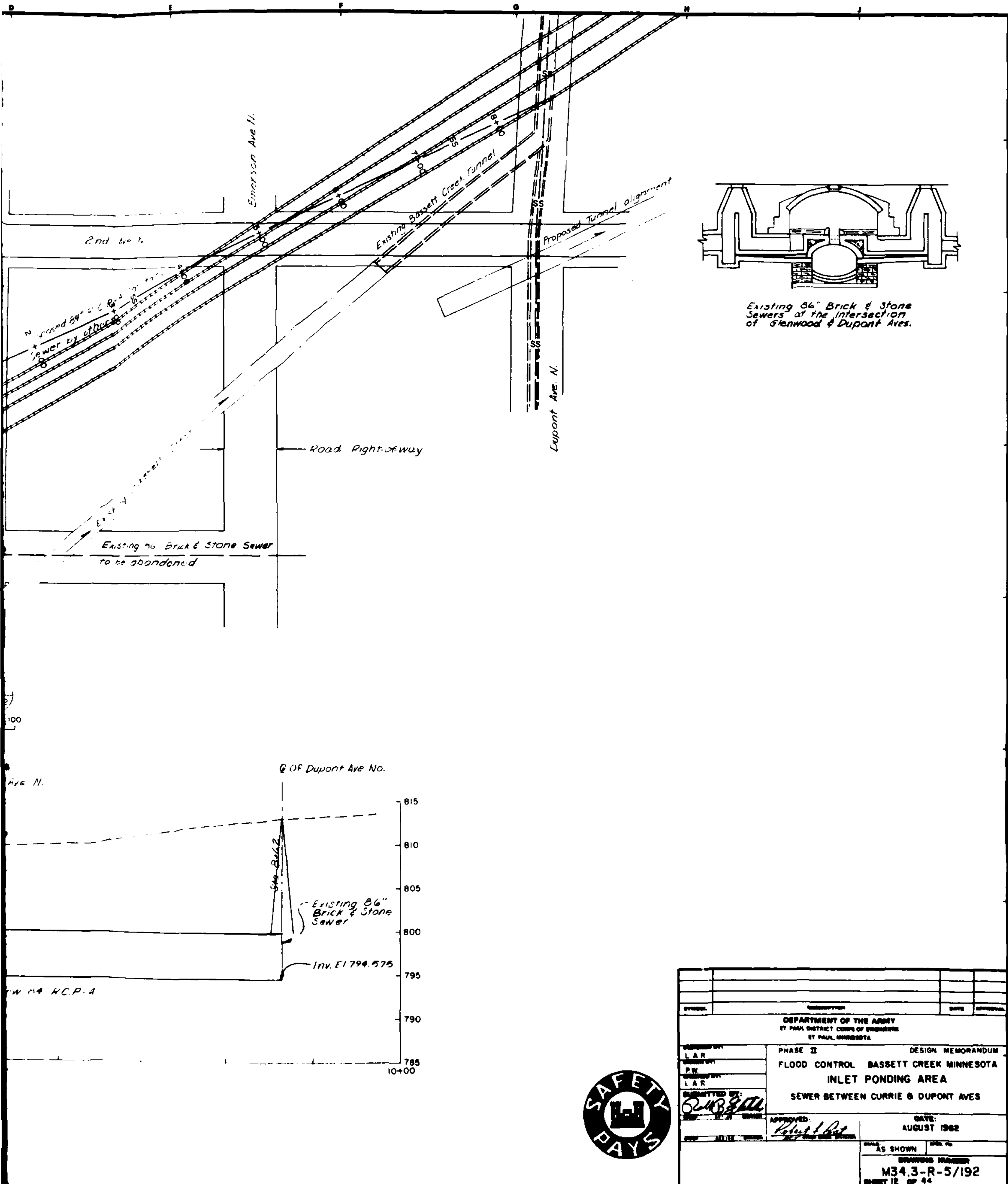
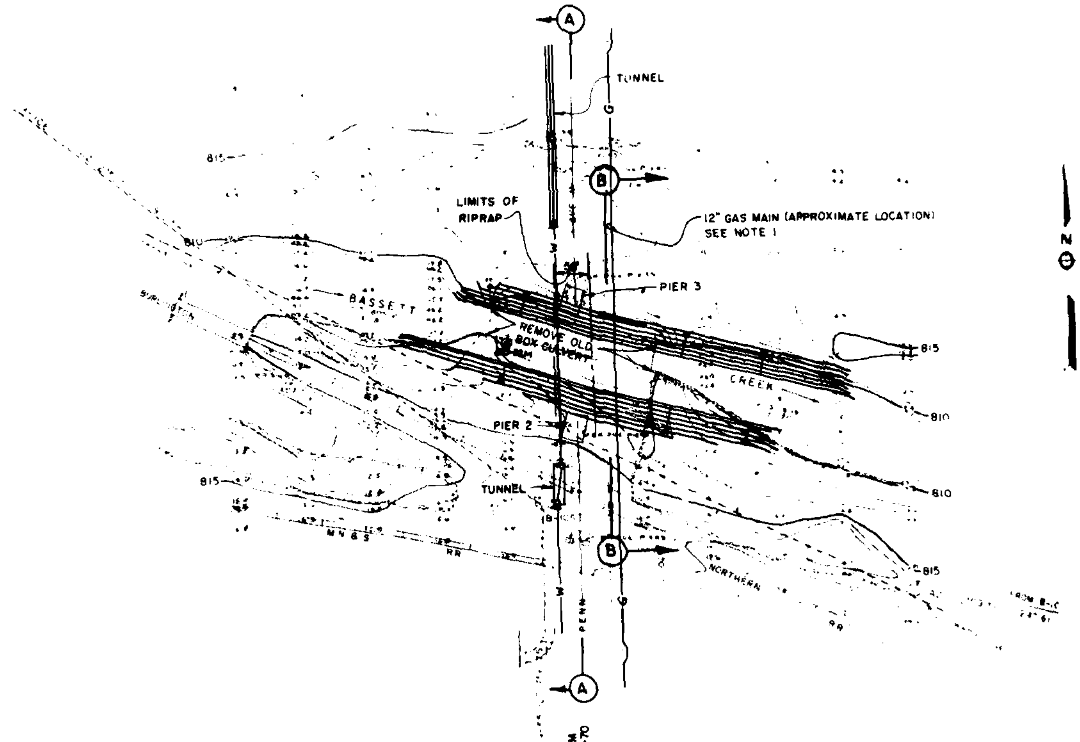

Emerson Ave N.
2nd Ave N.
Existing Bassett Creek Tunnel
Proposed Tunnel alignment
Proposed 84" R.C.P.
Sewer by others
SS
8+00
7+00
Dupont Ave. N.
Road Right-of-way
Existing 86" Brick & Stone Sewer
to be abandoned
Existing 86" Brick & Stone Sewers at the Intersection of Glenwood & Dupont Aves.
℄ Of Dupont Ave No.
Sta. 8+62
Existing 86" Brick & Stone Sewer
Inv. El 794.575
84" R.C.P.
815
810
805
800
795
790
785
10+00
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
L A R
P W
L A R
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
INLET PONDING AREA
SEWER BETWEEN CURRIE & DUPONT AVES
SUBMITTED BY:
APPROVED:
DATE:
AUGUST 1982
AS SHOWN
DRAWING NUMBER
M34.3-R-5/192
SHEET 12 OF 44
SAFETY PAYS

PLATE 12



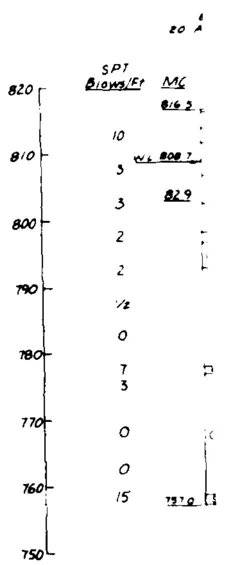
NOTES:

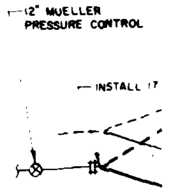
1 THE 12" GAS MAIN SHALL BE RELOCATED ON PENN AVE BRIDGE PRIOR TO REMOVAL OF THE BOX CULVERT.

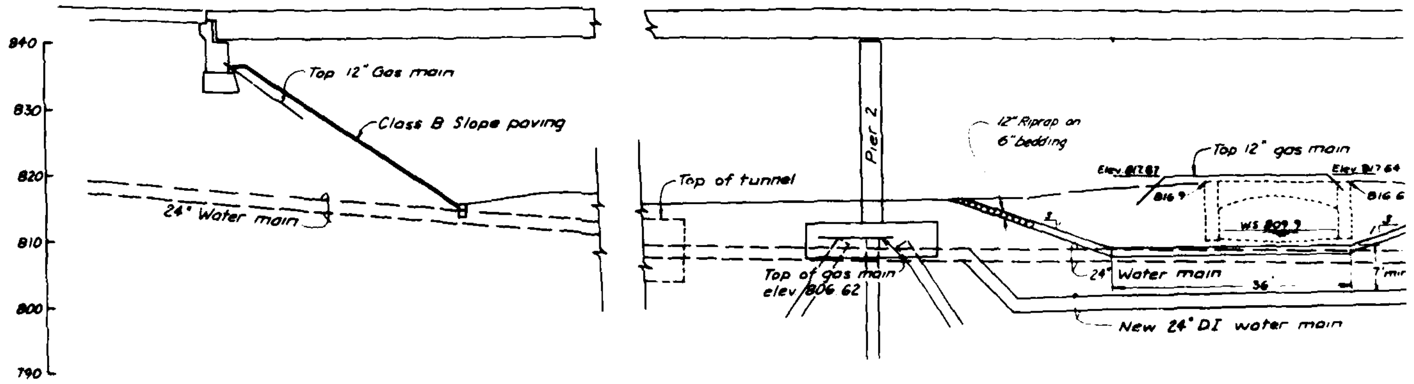
PLAN

SCALE IN FEET

0 25 50 100



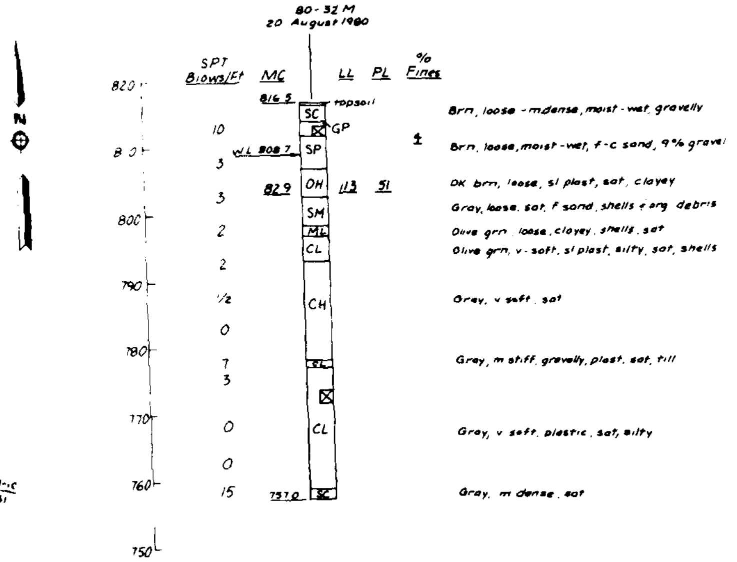




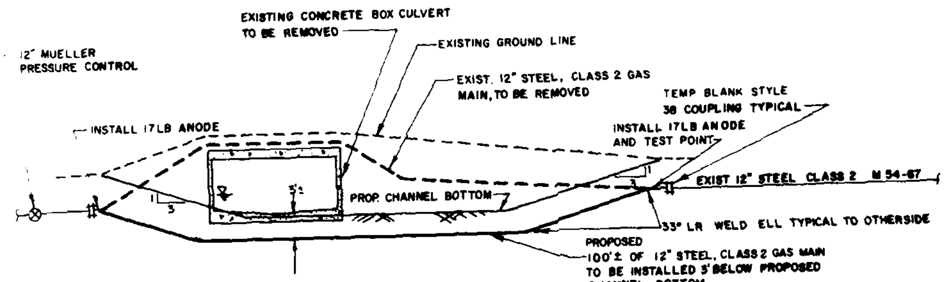
SECTION A-A

10 5 0 10 20

SCALE IN FEET

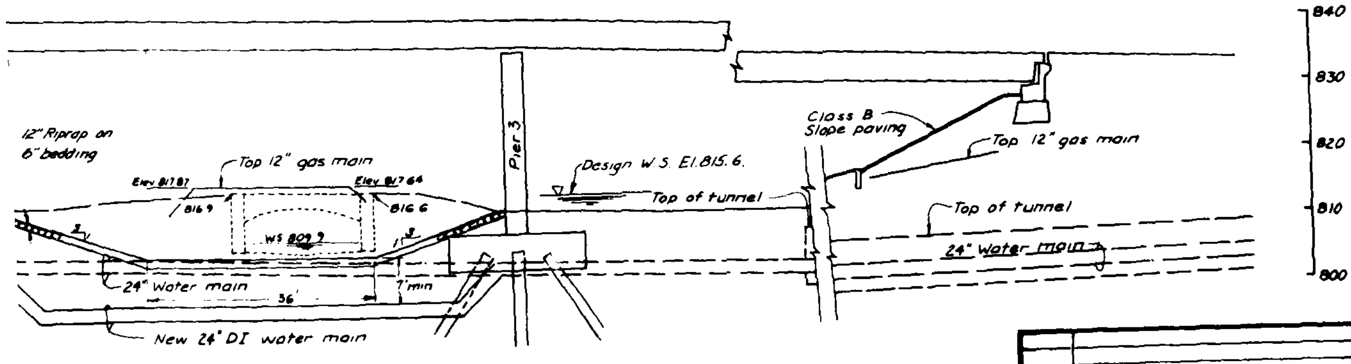


BE RELOCATED ON
R TO REMOVAL OF



SECTION B-B

10 5 0 10 20 30
SCALE IN FEET



SECTION A-A

10 5 0 10 20
SCALE IN FEET

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

L.A.R., D.W.R.
J.M.J.
L.A.R.

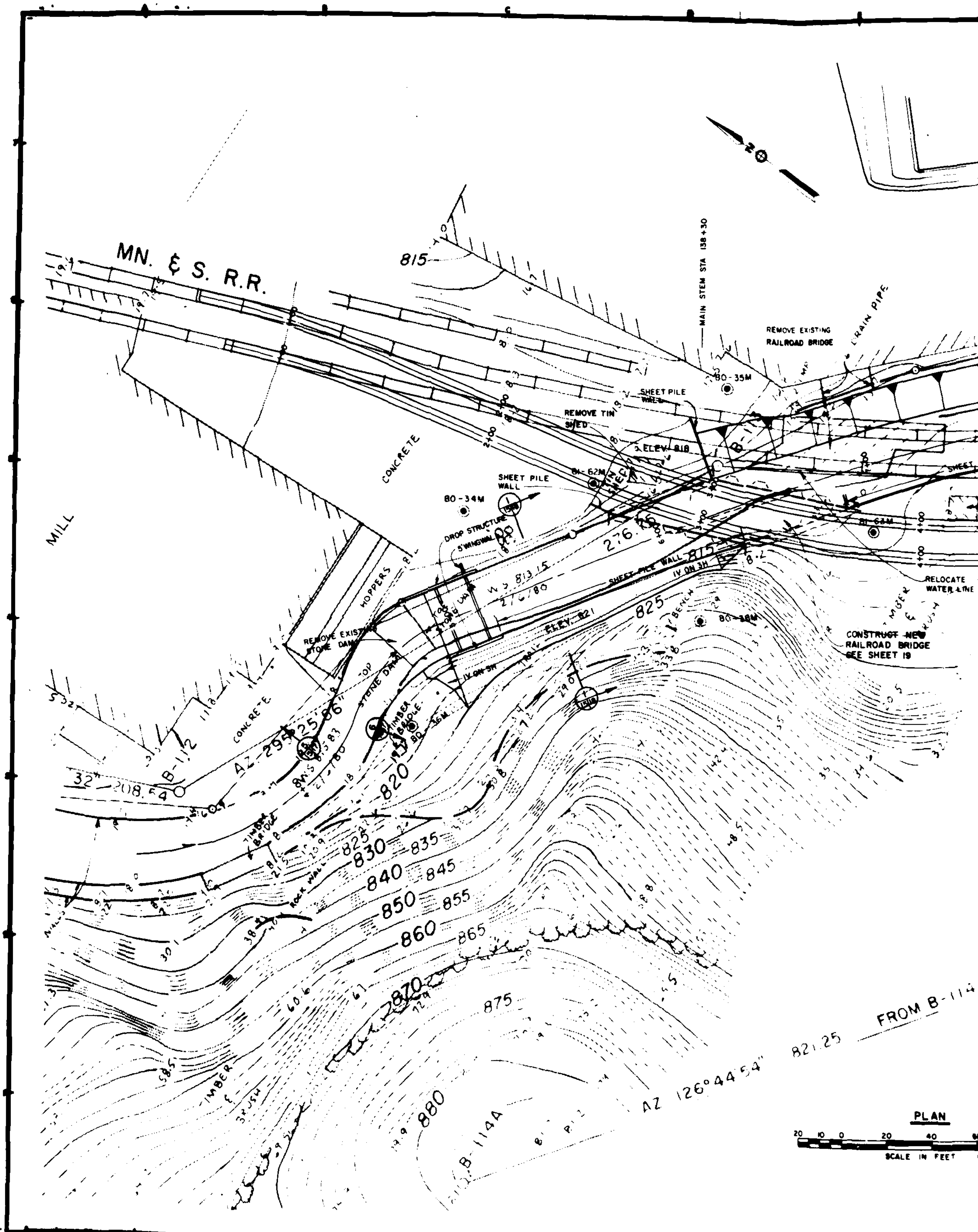
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

PENN AVE. CULVERT REMOVAL

AUGUST 1982
AS SHOWN
M34 3-R-5/194
14 of 44

SAFETY PAYS

PLATE 14



MN. & S. R.R.
MAIN STEM STA 138+30
REMOVE EXISTING RAILROAD BRIDGE
DRAIN PIPE
SHEET PILE WALL
REMOVE TIN SHED
ELEV. 818
80-35M
81-62M
80-34M
81-63M
CONCRETE
MILL
HOPPERS
DROP STRUCTURE
5' WINGWALL
REMOVE EXISTING STONE DAM
STONE DAM
TIMBER BRIDGE
SHEET PILE WALL
1V ON 3H
BENCH
ELEV. 821
80-38M
RELOCATE WATER LINE
CONSTRUCT NEW RAILROAD BRIDGE SEE SHEET 19
TIMBER & BRUSH
ROCK WALL
B-112
B-114A
AZ 126°44'54"
821.25
FROM B-114
PLAN
SCALE IN FEET

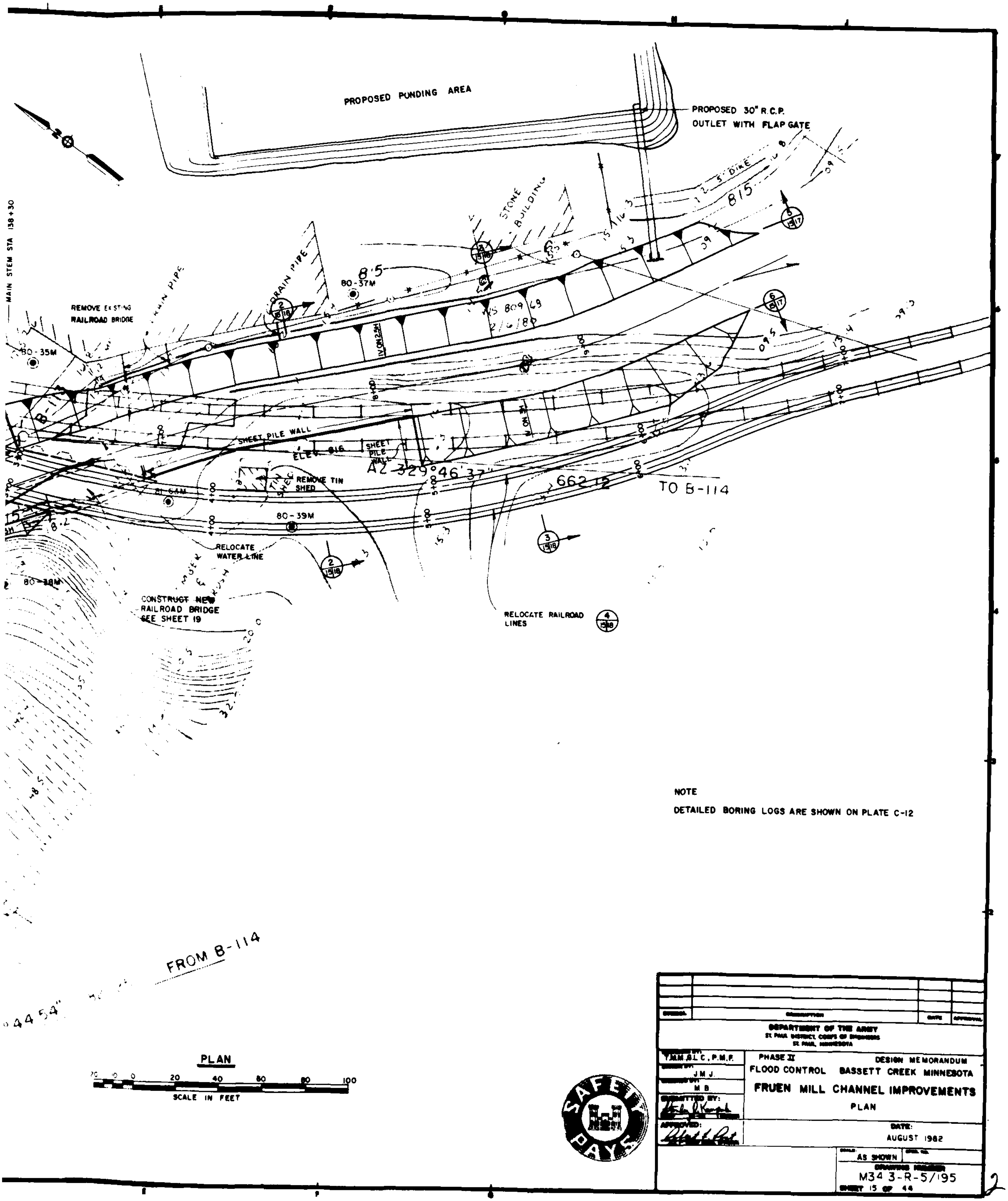
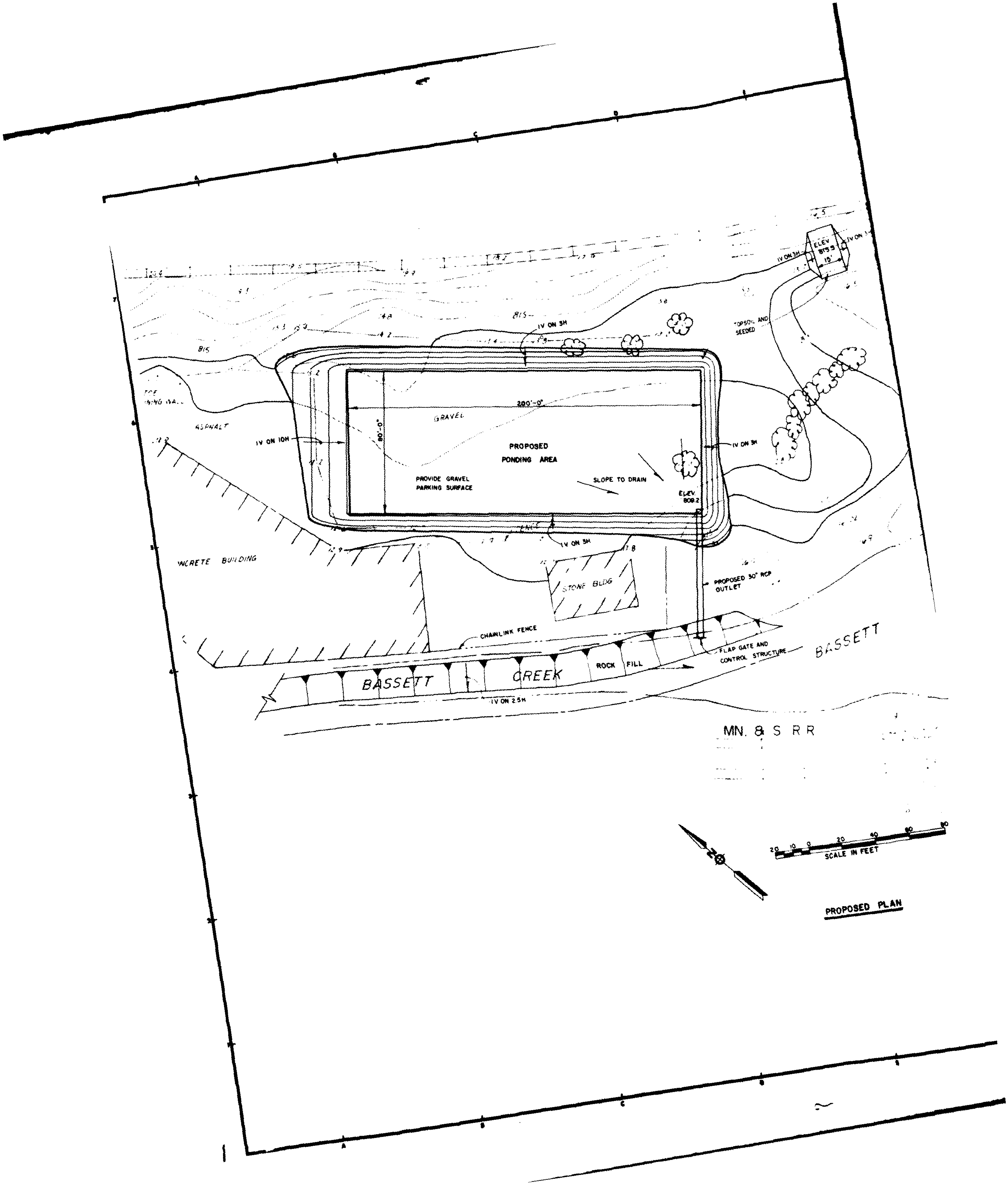
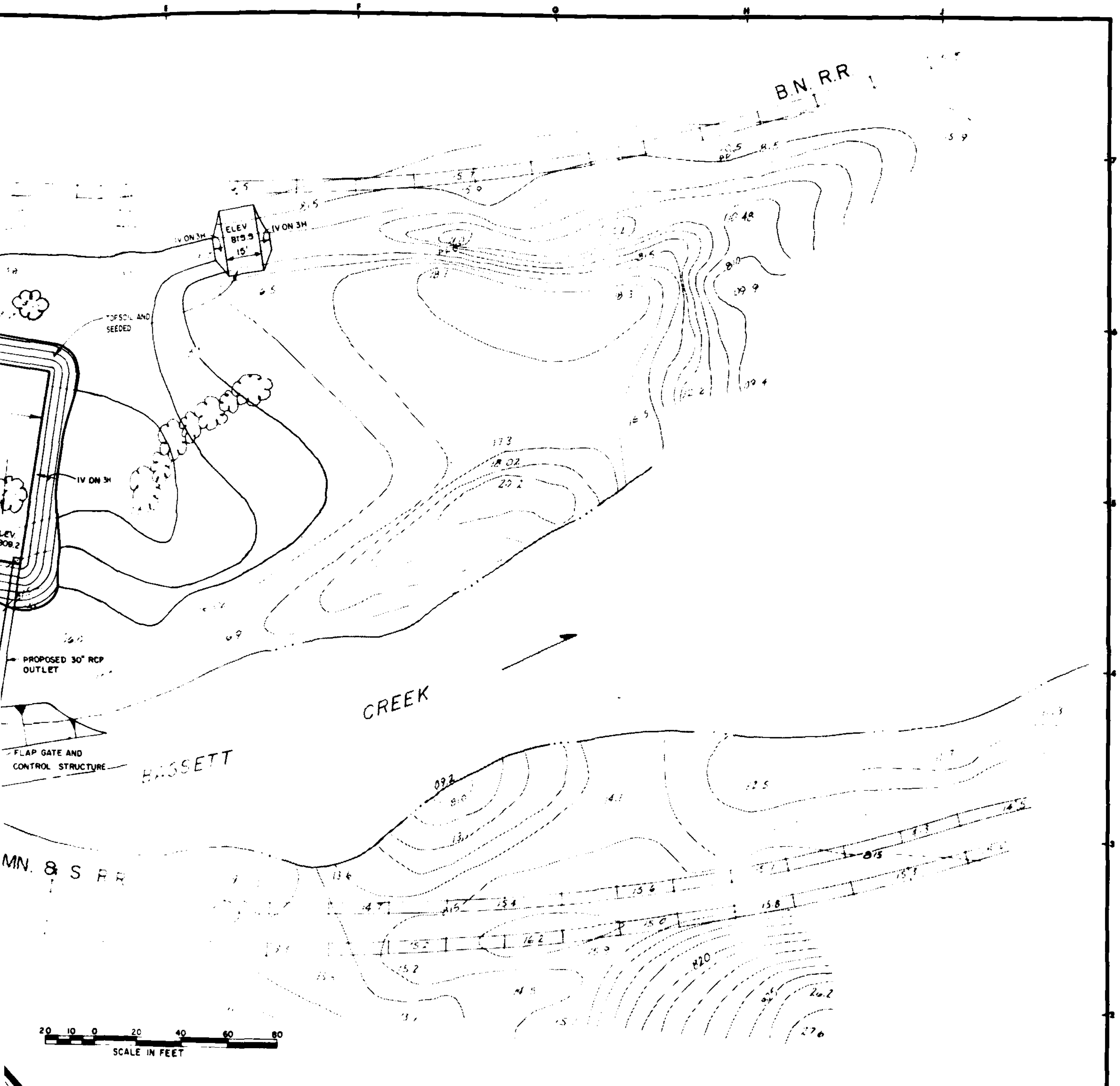

PROPOSED PONDING AREA
PROPOSED 30" R.C.P. OUTLET WITH FLAP GATE
STONE BUILDING
DRAIN PIPE
REMOVE EXISTING RAILROAD BRIDGE
MAIN STEM STA 138+30
SHEET PILE WALL
ELEV 816
SHEET PILE WALL
REMOVE TIN SHED
AZ 329°46'37"
662.2
TO B-114
80-35M
80-37M
80-39M
80-38M
RELOCATE WATER LINE
CONSTRUCT NEW RAILROAD BRIDGE SEE SHEET 19
RELOCATE RAILROAD LINES
NOTE
DETAILED BORING LOGS ARE SHOWN ON PLATE C-12
FROM B-114
PLAN
SCALE IN FEET
SAFETY PAYS
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
FRUEN MILL CHANNEL IMPROVEMENTS
PLAN
DATE: AUGUST 1982
AS SHOWN
M343-R-5/195
SHEET 15 OF 44

PLATE 15



ELEV 813.5
15'
IV ON 3H
TOPSOIL AND SEEDED
815
IV ON 5H
200'-0"
80'-0"
GRAVEL
ASPHALT
IV ON 10H
PROPOSED
PONDING AREA
PROVIDE GRAVEL
PARKING SURFACE
SLOPE TO DRAIN
ELEV. 809.2
IV ON 5H
CONCRETE BUILDING
STONE BLDG
PROPOSED 30" RCP OUTLET
CHAINLINK FENCE
FLAP GATE AND CONTROL STRUCTURE
ROCK FILL
BASSETT CREEK
BASSETT
IV ON 2.5H
MN. & S RR
SCALE IN FEET
PROPOSED PLAN



PROPOSED PLAN

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

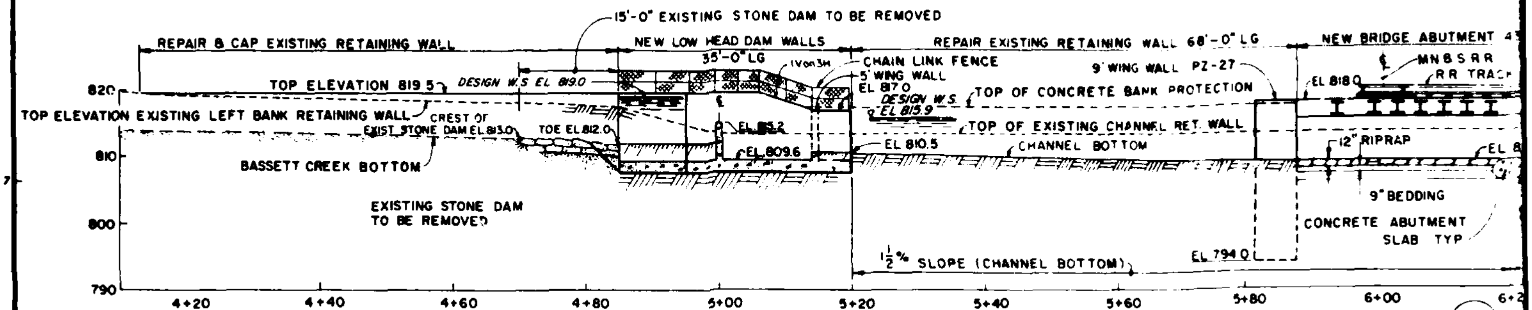
DESIGNED BY: M.D.L., T.M.M.
DRAWN BY: J.G.J.
CHECKED BY: M.B.
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

FRUEN MILL PONDING AREA

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER M34.3-R-5/196
SHEET 16 OF 44

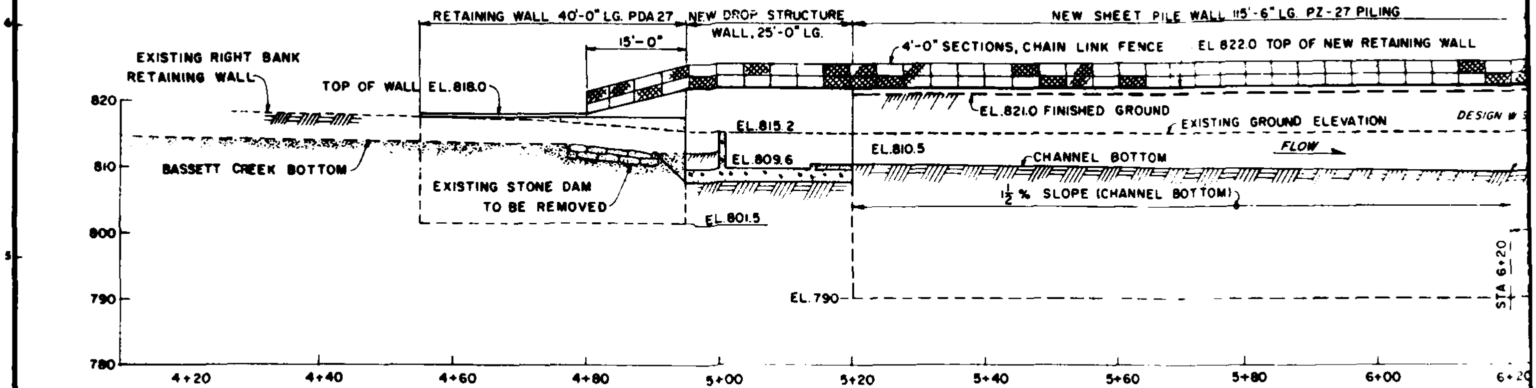
PLATE 16



RETAINING WALL PROFILE 5/15|17

LEFT BANK

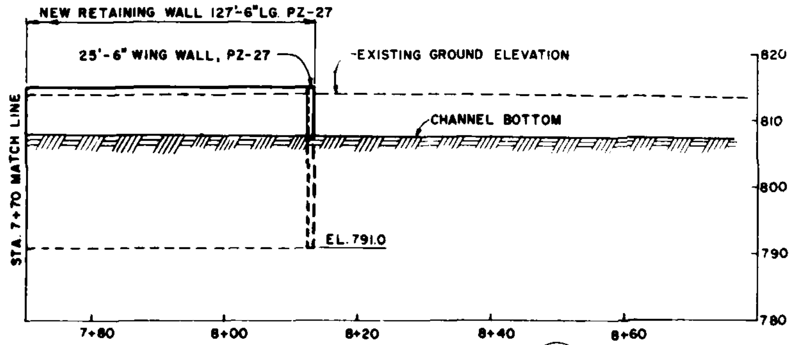
SECTION TAKEN AT 5' FROM FACE OF WALL



RETAINING WALL PROFILE 6/8|17

RIGHT BANK

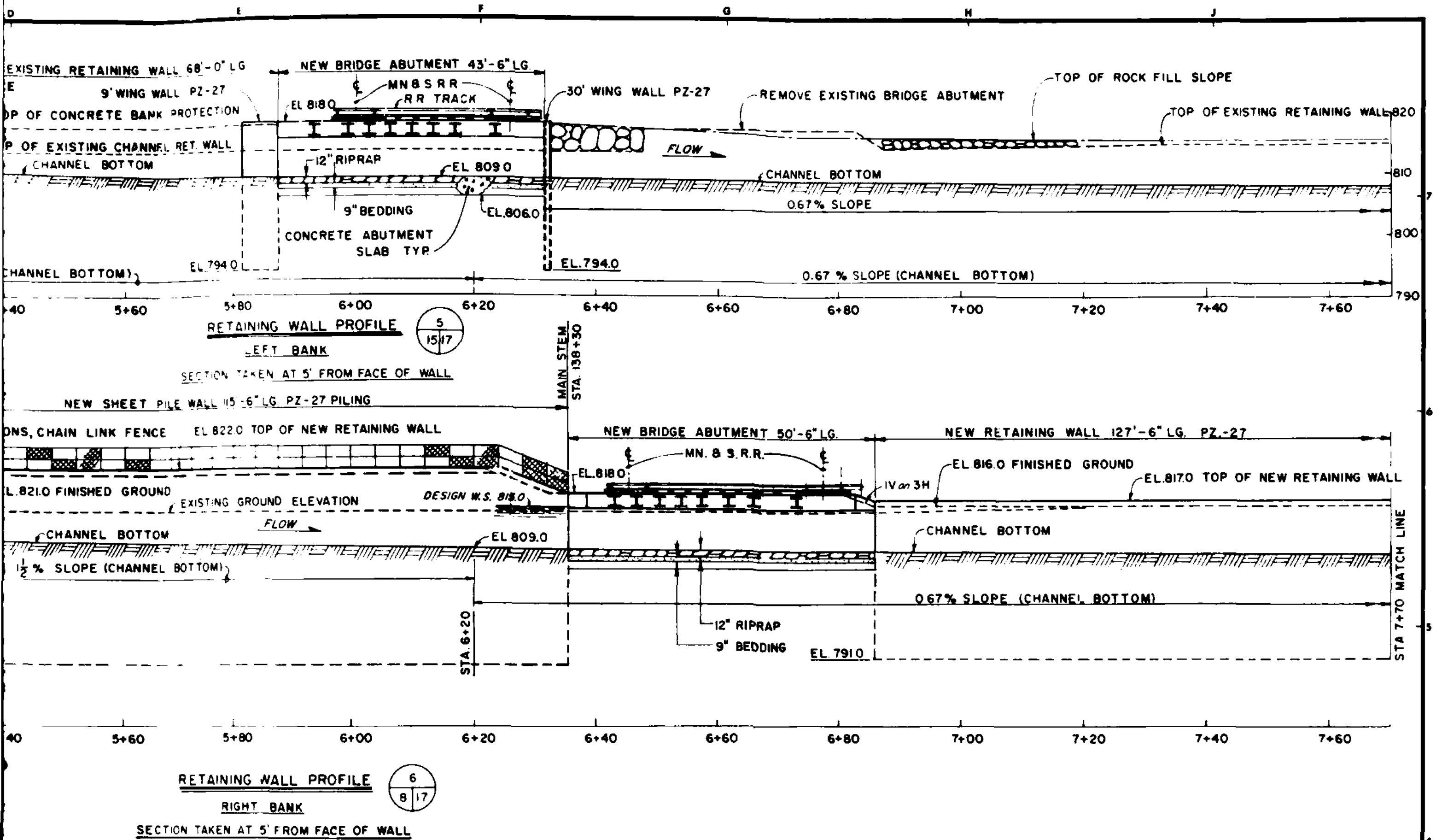
SECTION TAKEN AT 5' FROM FACE OF WALL



RETAINING WALL PROFILE 6/15|17

RIGHT BANK

SECTION TAKEN AT 5' FROM FACE OF WALL



NOTE:
1.REMOVE EXISTING BRIDGE ABUTMENTS

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

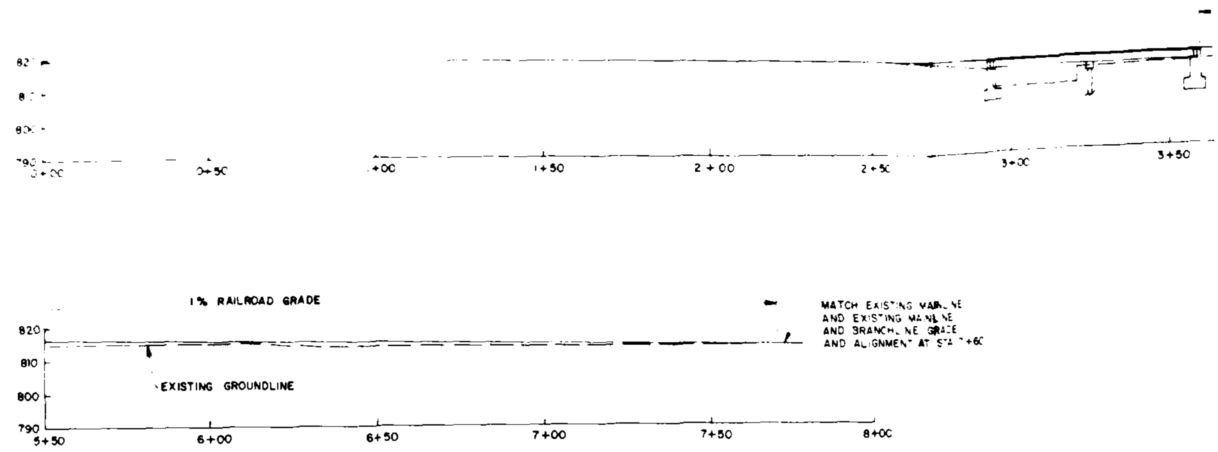
DESIGNED BY: T M M & G L C
DRAWN BY: K M
CHECKED BY: G L C

PHASE II
FLOOD CONTROL
DESIGN MEMORANDUM
BASSETT CREEK MINNESOTA

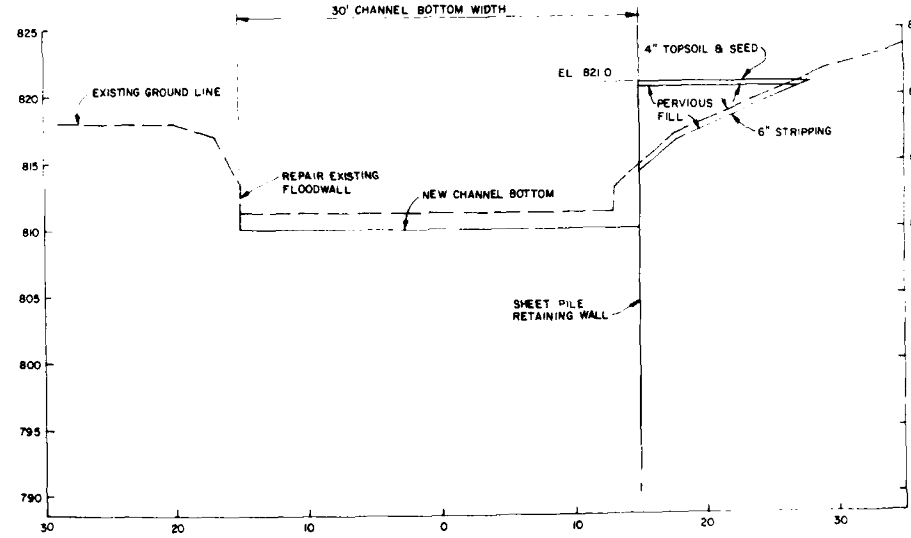
FRUEN MILL AREA
RETAINING WALL DETAILS

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-57/197
SHEET 17 OF 44

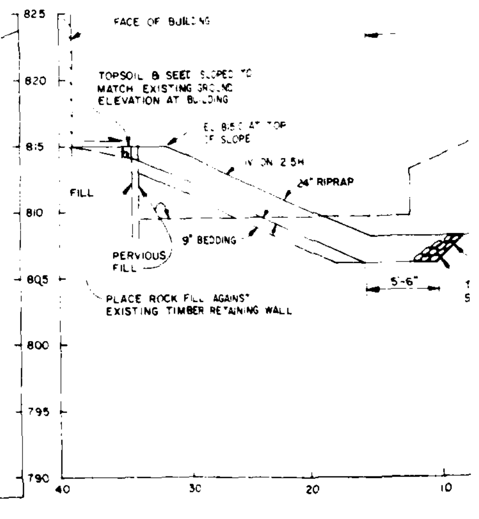
PLATE 17

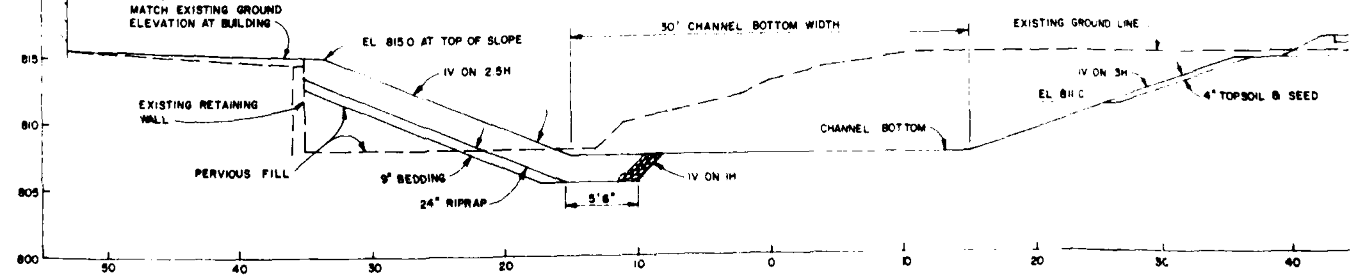


RAILROAD MAINLINE AND BRANCHLINE PROFILE
SCALE 1" = 20'



SECTION 1/15|18
SCALE 1" = 5'





SECTION 3/15|18
SCALE 1" = 5'

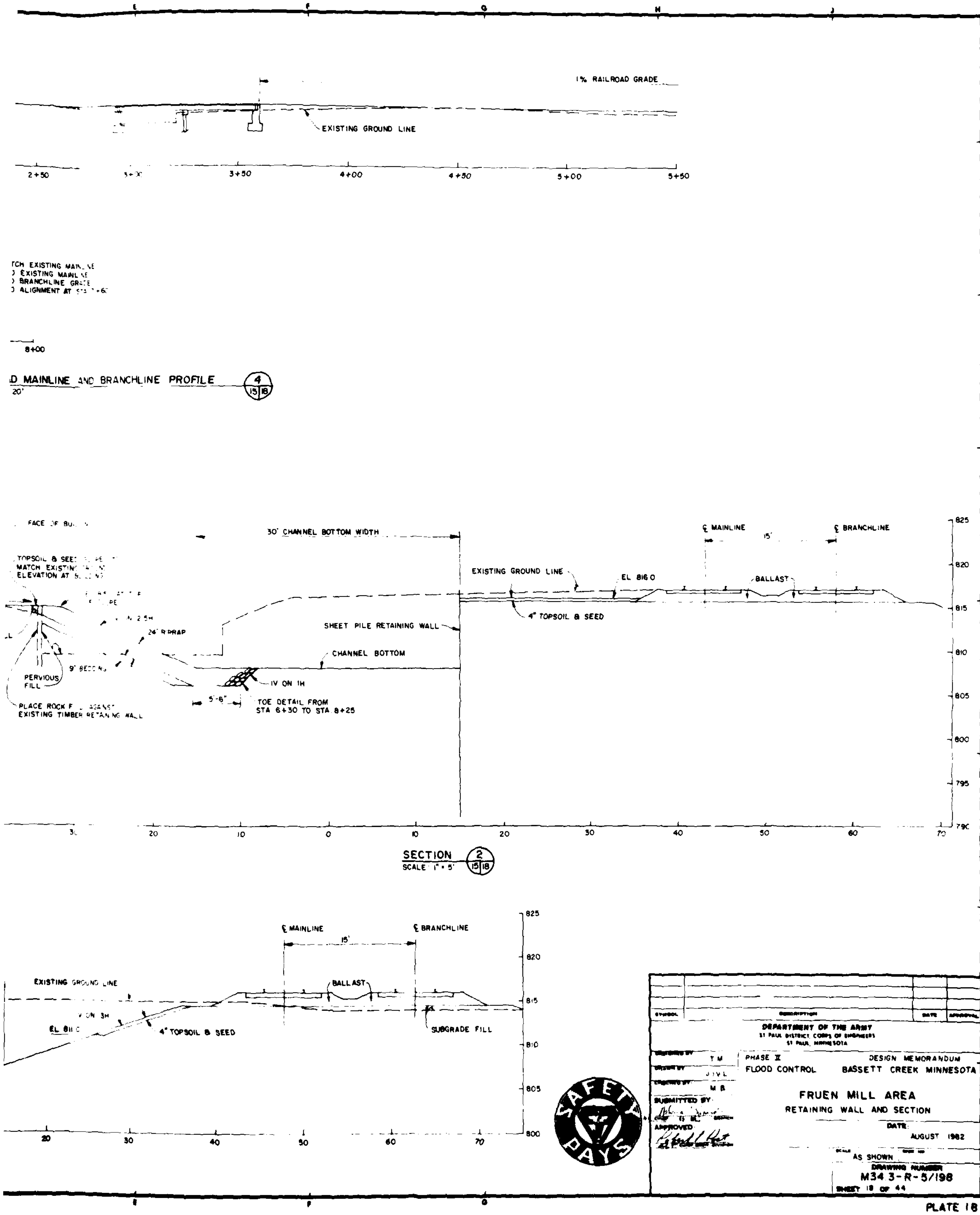
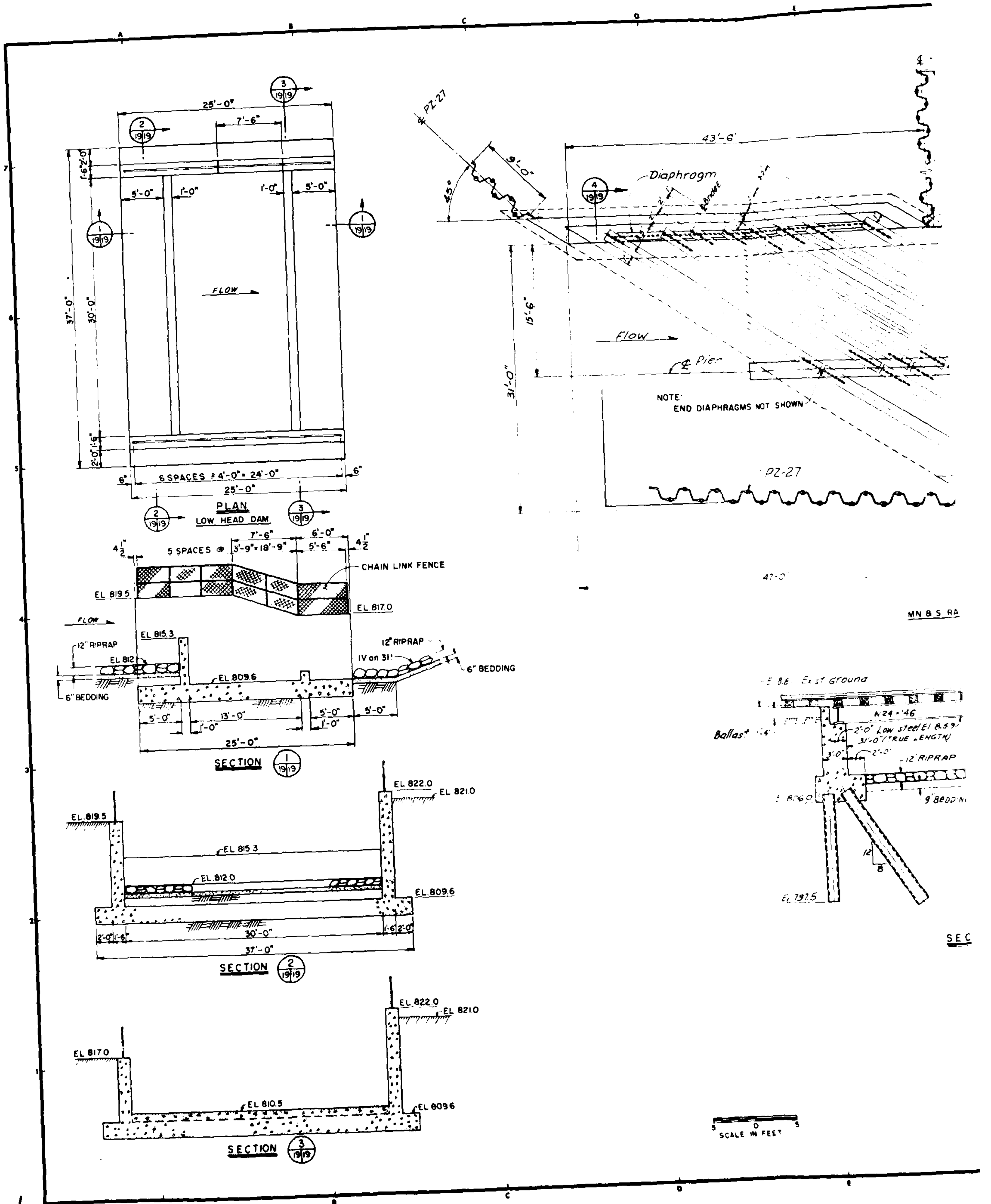
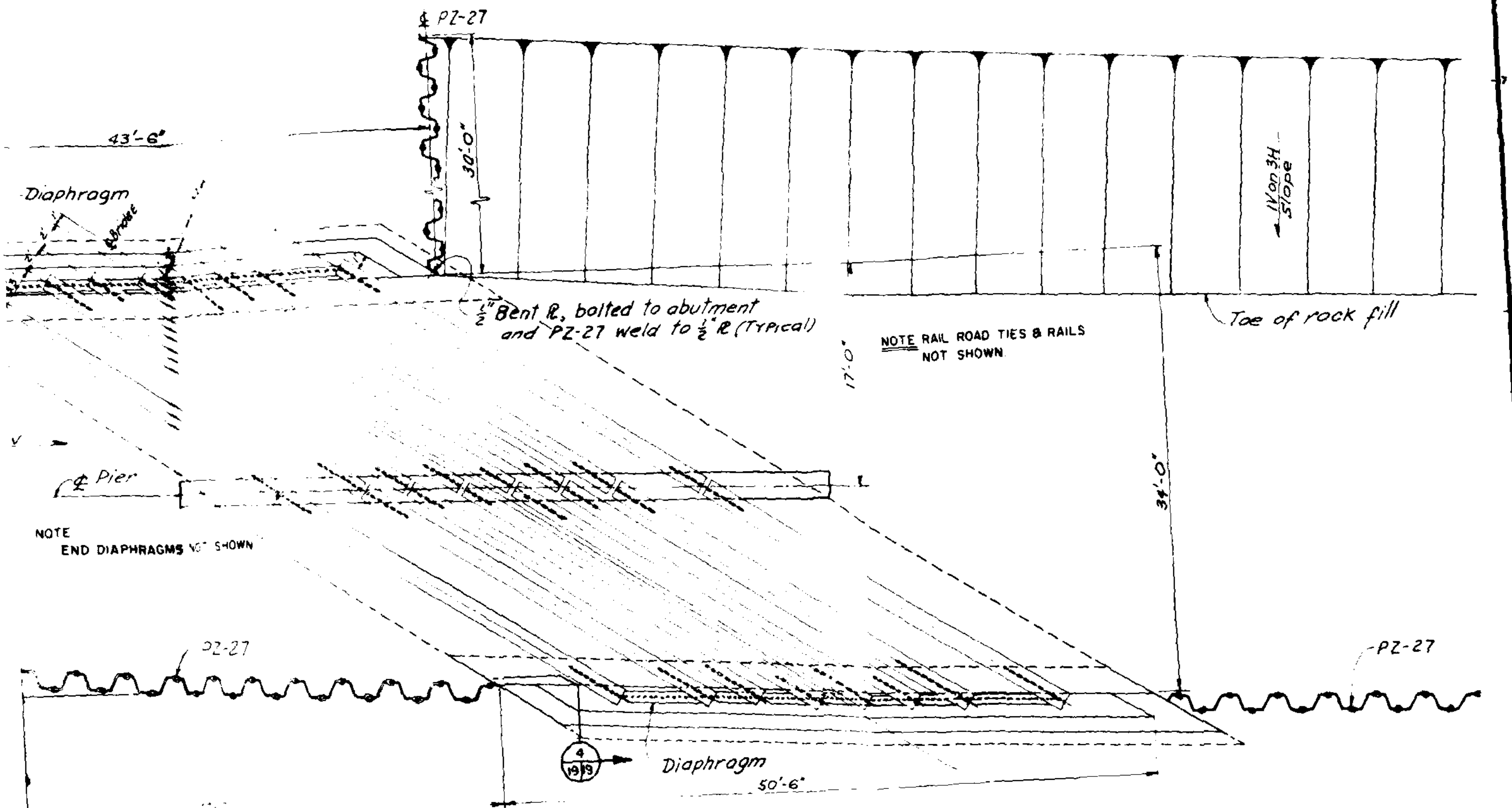

1% RAILROAD GRADE
EXISTING GROUND LINE
2+50
3+50
4+00
4+50
5+00
5+50
EXISTING MAINLINE
BRANCHLINE GRADE
ALIGNMENT AT STA
8+00
MAINLINE AND BRANCHLINE PROFILE
FACE OF BUILDING
30' CHANNEL BOTTOM WIDTH
TOPSOIL & SEED
MATCH EXISTING
ELEVATION AT BUILDING
24" RIPRAP
9" BEDDING
PERVIOUS FILL
PLACE ROCK FILL AGAINST EXISTING TIMBER RETAINING WALL
5'-6"
TOE DETAIL FROM STA 6+30 TO STA 8+25
1V ON 1H
CHANNEL BOTTOM
SHEET PILE RETAINING WALL
EXISTING GROUND LINE
EL 816.0
4" TOPSOIL & SEED
℄ MAINLINE
15'
℄ BRANCHLINE
BALLAST
825
820
815
810
805
800
795
790
SECTION
SCALE 1" = 5'
EXISTING GROUND LINE
1V ON 3H
EL 816.0
4" TOPSOIL & SEED
SUBGRADE FILL
SAFETY PAYS
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL
BASSETT CREEK MINNESOTA
FRUEN MILL AREA
RETAINING WALL AND SECTION
DATE:
AUGUST 1982
AS SHOWN
DRAWING NUMBER
M343-R-5/198
SHEET 18 OF 44

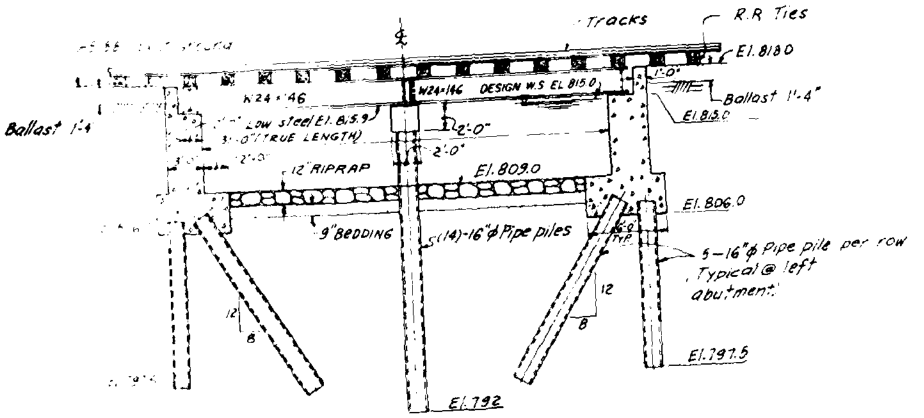
PLATE 18



PLAN
LOW HEAD DAM
25'-0"
7'-6"
5'-0"
1'-0"
FLOW
37'-0"
30'-0"
6 SPACES @ 4'-0" = 24'-0"
SECTION 1/1919
5 SPACES @ 3'-9" = 18'-9"
6'-0"
5'-6"
CHAIN LINK FENCE
EL 819.5
EL 817.0
EL 815.3
12" RIPRAP
EL 812
EL 809.6
6" BEDDING
1V on 3½
13'-0"
SECTION 2/1919
EL 822.0
EL 821.0
EL 812.0
SECTION 3/1919
EL 810.5
43'-6"
9'-0"
45°
PZ-27
Diaphragm
Flow
℄ Pier
15'-6"
31'-0"
NOTE:
END DIAPHRAGMS NOT SHOWN
MN & S RA
Ballast
12" RIPRAP
9" BEDDING
W 24 x 46
EL 797.5
SCALE IN FEET



PLAN
MN & S RAILROAD BRIDGE



SECTION 4/19|19

5 0 5
SCALE IN FEET

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY LHBBGLC
DRAWN BY
CHECKED BY GLC
SUBMITTED BY
APPROVED

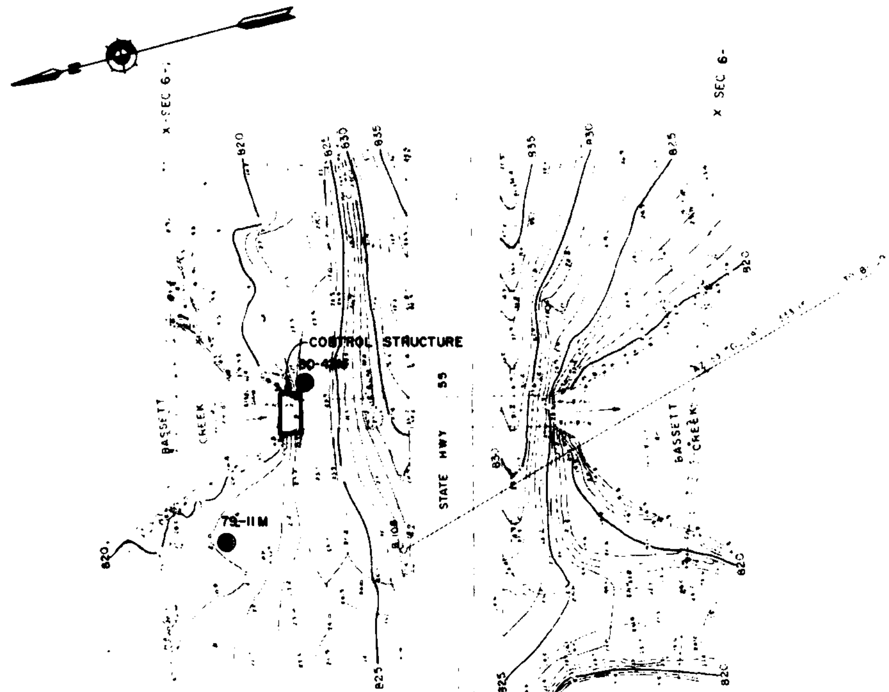
PHASE II
FLOOD CONTROL
DESIGN MEMORANDUM
BASSETT CREEK MINNESOTA

FRUEN MILL AREA
RAILROAD BRIDGE & DROP STRUCTURE DETAILS

DATE: AUGUST 1982
SCALE AS SHOWN
DRAWING NUMBER M34.3-R-57/99
SHEET 19 OF 44

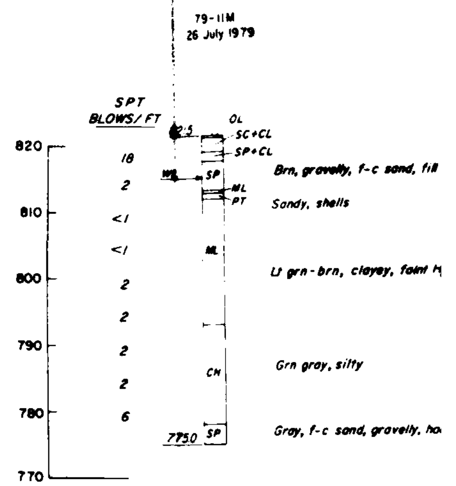
SAFETY PAYS

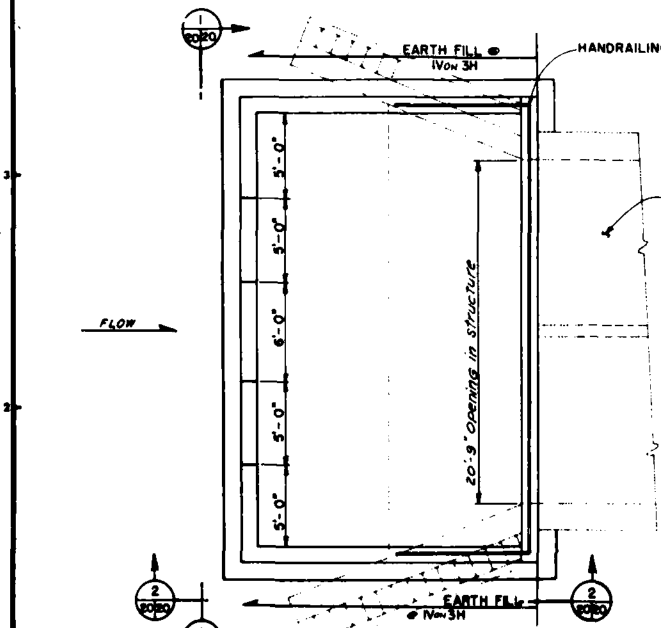
PLATE 19



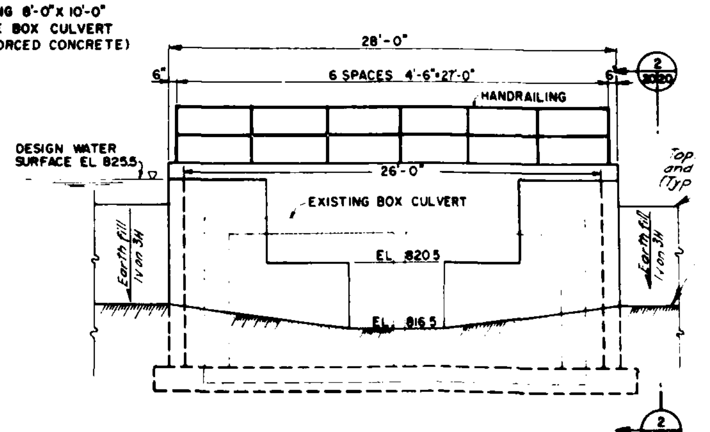
PLAN
CONTROL STRUCTURE LOCATION

0 25 50 100
SCALE IN FEET

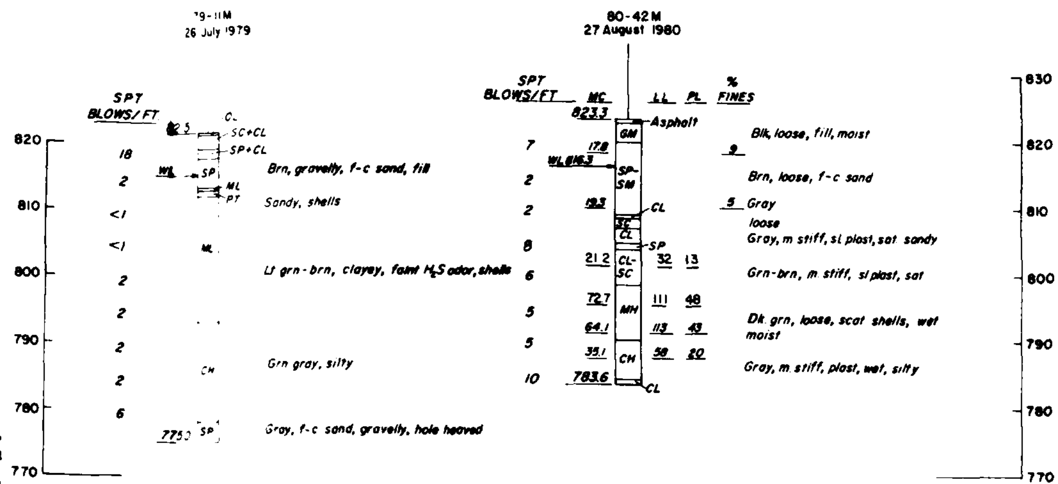




PLAN

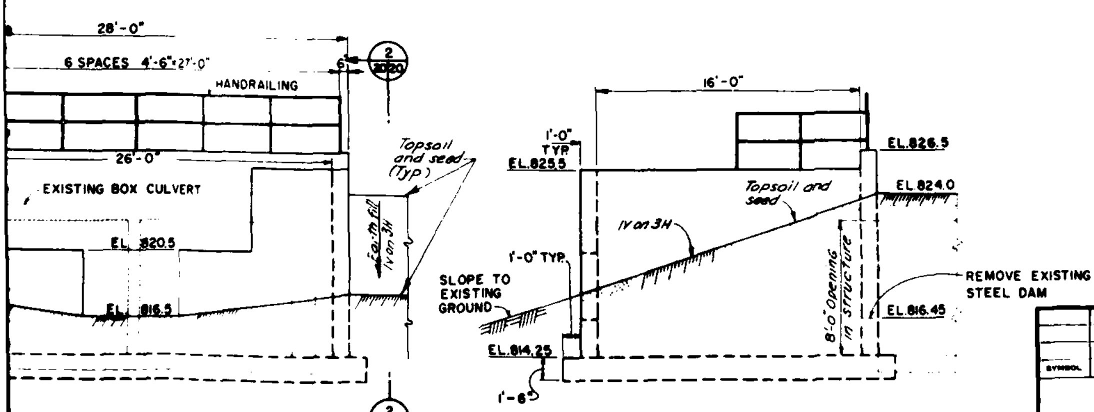


SECTION 1/2020



NOTE:

BORING LEGEND SHOWN ON PLATE C-11



SECTION 1/2020

SECTION 2/2020

SCALE IN FEET

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY D.M.T.
CHECKED BY G.L.C.
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

HIGHWAY 55 CONTROL STRUCTURE
PLAN & SECTIONS

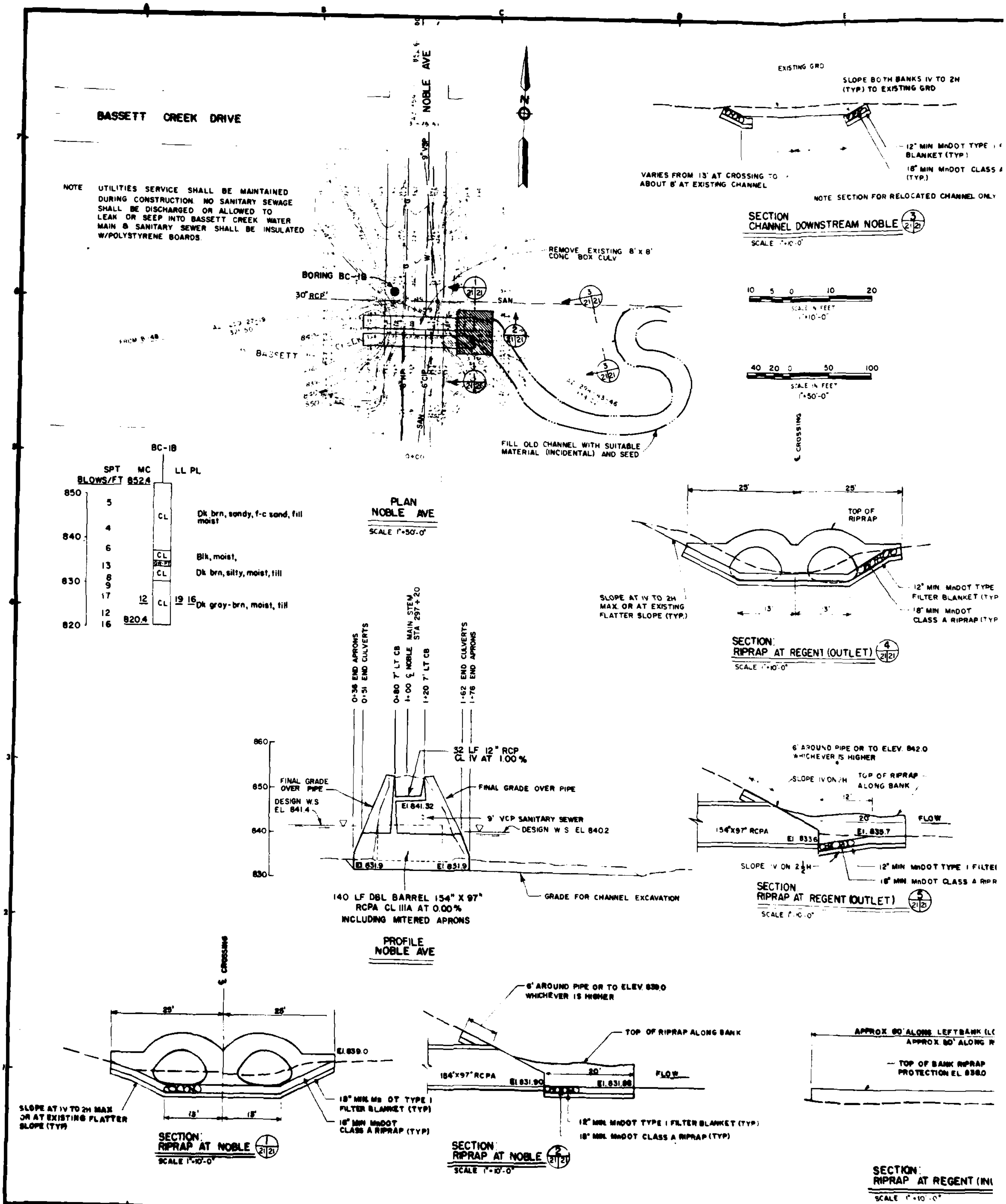
DATE: AUGUST 1982

SCALE: AS SHOWN

DRAWING NUMBER
M34.3-R-5/201
SHEET 20 OF 44

2

PLATE 20


BASSETT CREEK DRIVE
NOBLE AVE
N
NOTE UTILITIES SERVICE SHALL BE MAINTAINED DURING CONSTRUCTION. NO SANITARY SEWAGE SHALL BE DISCHARGED OR ALLOWED TO LEAK OR SEEP INTO BASSETT CREEK. WATER MAIN & SANITARY SEWER SHALL BE INSULATED W/POLYSTYRENE BOARDS.
BORING BC-1B
30" RCP
SAN
REMOVE EXISTING 8' x 8' CONC BOX CULV
BASSETT
FILL OLD CHANNEL WITH SUITABLE MATERIAL (INCIDENTAL) AND SEED
PLAN NOBLE AVE
SCALE 1"=50'-0"
BC-1B
SPT BLOWS/FT
MC 852.4
LL PL
Dk brn, sandy, f-c sand, fill moist
Blk, moist,
Dk brn, silty, moist, till
Dk gray-brn, moist, till
820.4
EXISTING GRD
SLOPE BOTH BANKS 1V TO 2H (TYP) TO EXISTING GRD
12" MIN MnDOT TYPE I F BLANKET (TYP)
18" MIN MnDOT CLASS A (TYP)
VARIES FROM 13' AT CROSSING TO ABOUT 8' AT EXISTING CHANNEL
NOTE SECTION FOR RELOCATED CHANNEL ONLY
SECTION CHANNEL DOWNSTREAM NOBLE
SCALE 1"=10'-0"
SCALE IN FEET 1"=10'-0"
SCALE IN FEET 1"=50'-0"
℄ CROSSING
TOP OF RIPRAP
SLOPE AT 1V TO 2H MAX. OR AT EXISTING FLATTER SLOPE (TYP.)
12" MIN MnDOT TYPE FILTER BLANKET (TYP)
18" MIN MnDOT CLASS A RIPRAP (TYP)
SECTION RIPRAP AT REGENT (OUTLET)
SCALE 1"=10'-0"
0+36 END APRONS
0+51 END CULVERTS
0+80 7' LT CB
1+00 ℄ NOBLE MAIN STEM STA 297+20
1+20 7' LT CB
1+62 END CULVERTS
1+76 END APRONS
32 LF 12" RCP CL IV AT 1.00%
FINAL GRADE OVER PIPE
DESIGN W.S EL 841.4
EL 841.32
9" VCP SANITARY SEWER
DESIGN W S EL 840.2
EL 831.9
EL 831.9
GRADE FOR CHANNEL EXCAVATION
140 LF DBL BARREL 154" X 97" RCPA CL IIIA AT 0.00% INCLUDING MITERED APRONS
PROFILE NOBLE AVE
6' AROUND PIPE OR TO ELEV 842.0 WHICHEVER IS HIGHER
SLOPE 1V ON 2H
TOP OF RIPRAP ALONG BANK
FLOW
154"X97" RCPA
EL 833.6
EL 839.7
SLOPE 1V ON 2½H
12" MIN MnDOT TYPE I FILTER
18" MIN MnDOT CLASS A RIPRAP
SECTION RIPRAP AT REGENT (OUTLET)
SCALE 1"=10'-0"
EL 839.0
SLOPE AT 1V TO 2H MAX OR AT EXISTING FLATTER SLOPE (TYP)
18" MIN MnDOT TYPE I FILTER BLANKET (TYP)
18" MIN MnDOT CLASS A RIPRAP (TYP)
SECTION RIPRAP AT NOBLE
SCALE 1"=10'-0"
6' AROUND PIPE OR TO ELEV 839.0 WHICHEVER IS HIGHER
TOP OF RIPRAP ALONG BANK
154"X97" RCPA
EL 831.90
EL 831.86
FLOW
12" MIN MnDOT TYPE I FILTER BLANKET (TYP)
18" MIN MnDOT CLASS A RIPRAP (TYP)
SECTION RIPRAP AT NOBLE
SCALE 1"=10'-0"
APPROX 80' ALONG LEFT BANK
APPROX 80' ALONG R
TOP OF BANK RIPRAP PROTECTION EL 836.0
SECTION RIPRAP AT REGENT (IN
SCALE 1"=10'-0"

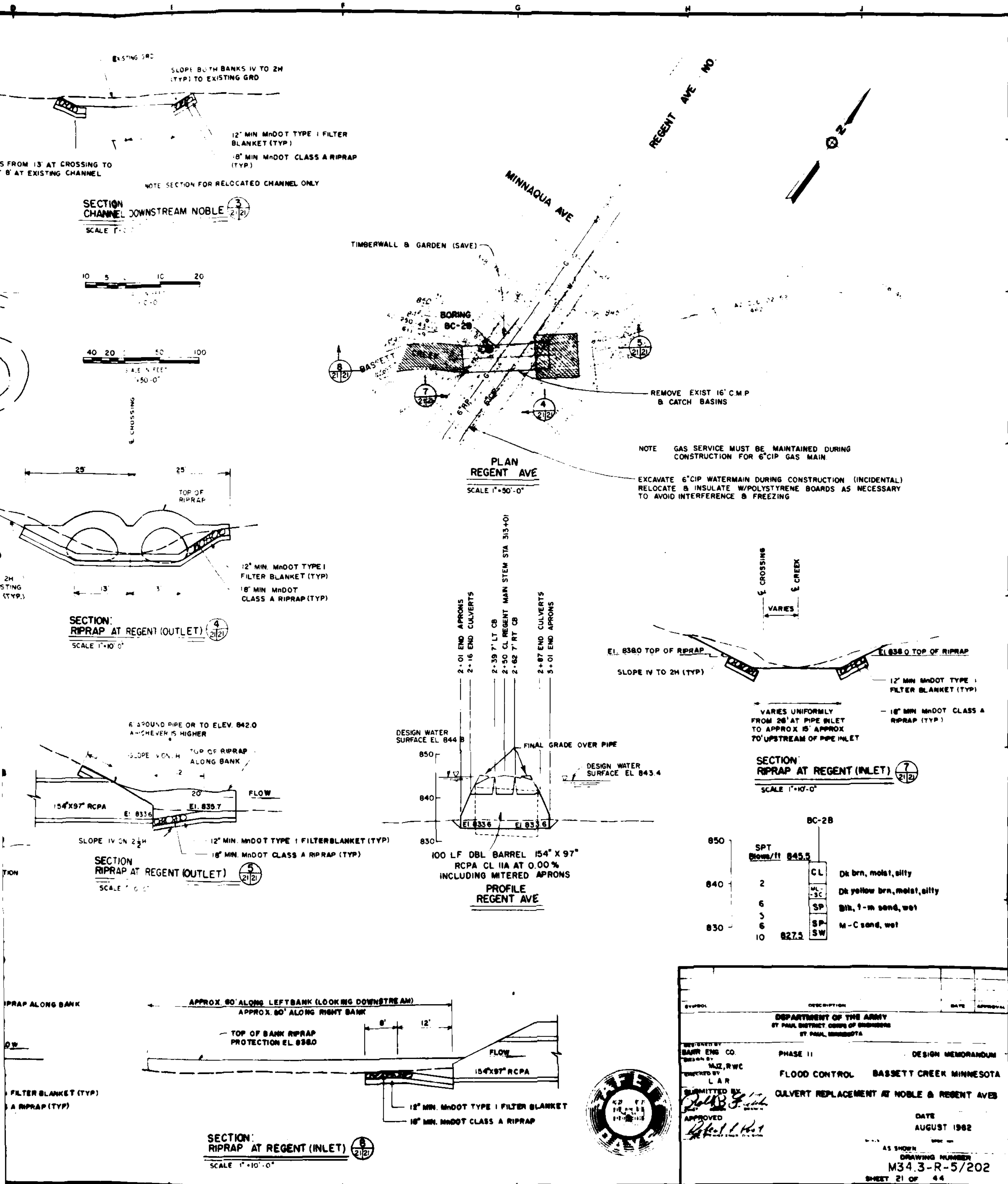
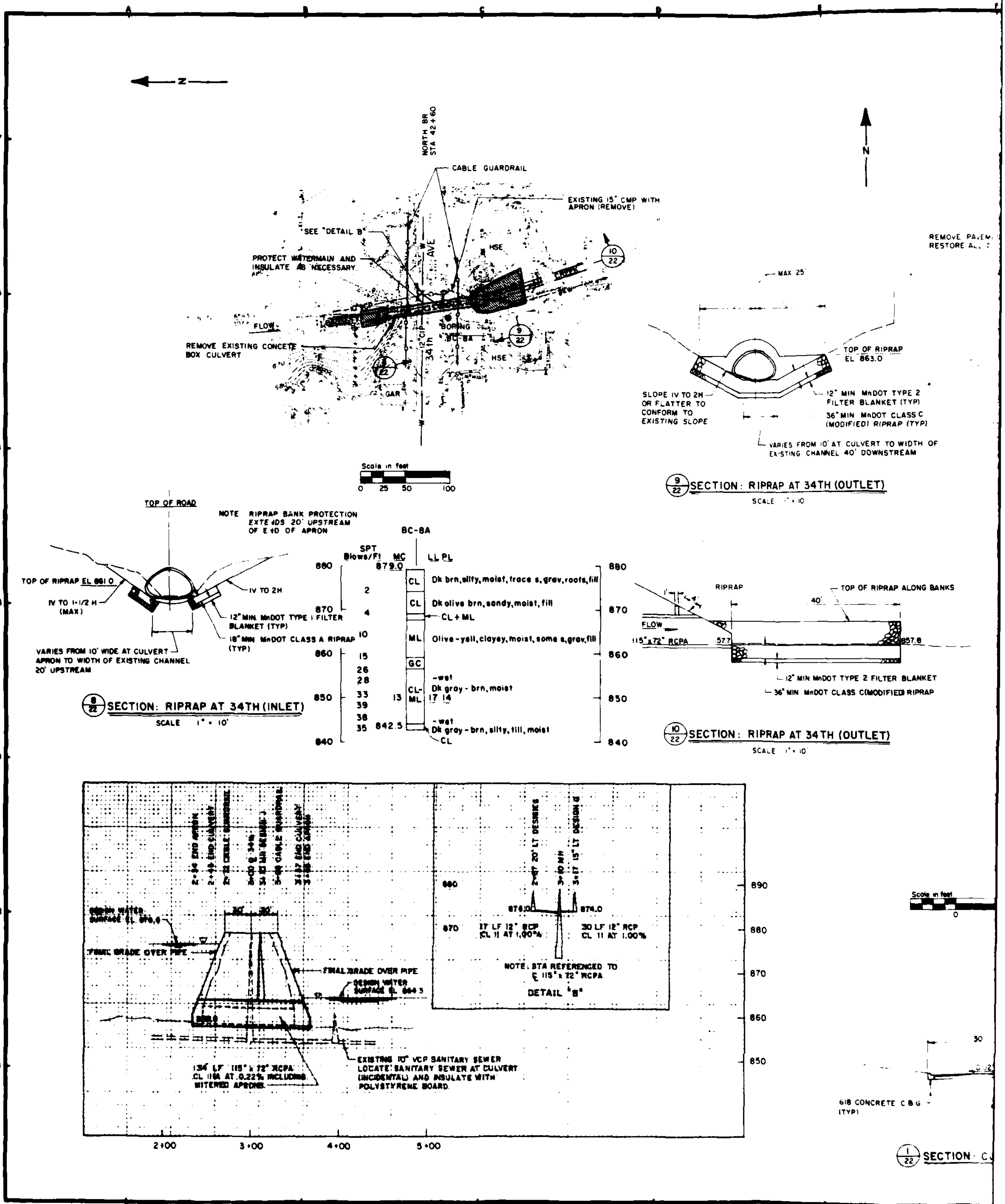

SLOPE BOTH BANKS 1V TO 2H (TYP) TO EXISTING GRD
12" MIN MnDOT TYPE I FILTER BLANKET (TYP)
18" MIN MnDOT CLASS A RIPRAP (TYP)
S FROM 13' AT CROSSING TO 8' AT EXISTING CHANNEL
NOTE SECTION FOR RELOCATED CHANNEL ONLY
SECTION CHANNEL DOWNSTREAM NOBLE
REGENT AVE NO
MINNAQUA AVE
TIMBERWALL & GARDEN (SAVE)
BORING BC-2B
BASSETT CREEK
REMOVE EXIST 16" C.M.P & CATCH BASINS
NOTE GAS SERVICE MUST BE MAINTAINED DURING CONSTRUCTION FOR 6"CIP GAS MAIN
PLAN REGENT AVE
SCALE 1"=50'-0"
EXCAVATE 6"CIP WATERMAIN DURING CONSTRUCTION (INCIDENTAL) RELOCATE & INSULATE W/POLYSTYRENE BOARDS AS NECESSARY TO AVOID INTERFERENCE & FREEZING
TOP OF RIPRAP
12" MIN. MnDOT TYPE I FILTER BLANKET (TYP)
18" MIN MnDOT CLASS A RIPRAP (TYP)
SECTION: RIPRAP AT REGENT (OUTLET)
SCALE 1"=10'-0"
2+01 END APRONS
2+16 END CULVERTS
2+39 7' LT CB
2+50 CL REGENT MAIN STEM STA 313+01
2+62 7' RT CB
2+87 END CULVERTS
3+01 END APRONS
DESIGN WATER SURFACE EL 844.8
FINAL GRADE OVER PIPE
DESIGN WATER SURFACE EL 843.4
EL 833.6
EL 833.6
100 LF DBL BARREL 154" X 97" RCPA CL IIA AT 0.00% INCLUDING MITERED APRONS
PROFILE REGENT AVE
℄ CROSSING
℄ CREEK
VARIES
EL 838.0 TOP OF RIPRAP
EL 838.0 TOP OF RIPRAP
SLOPE 1V TO 2H (TYP)
12" MIN MnDOT TYPE I FILTER BLANKET (TYP)
18" MIN MnDOT CLASS A RIPRAP (TYP)
VARIES UNIFORMLY FROM 28' AT PIPE INLET TO APPROX 15' APPROX 70' UPSTREAM OF PIPE INLET
SECTION: RIPRAP AT REGENT (INLET)
SCALE 1"=10'-0"
6' AROUND PIPE OR TO ELEV. 842.0 WHICHEVER IS HIGHER
SLOPE 1V ON 2H
TOP OF RIPRAP ALONG BANK
FLOW
154"X97" RCPA
EL 833.6
EL 835.7
SLOPE 1V ON 2½H
12" MIN. MnDOT TYPE I FILTERBLANKET (TYP)
18" MIN. MnDOT CLASS A RIPRAP (TYP)
SECTION RIPRAP AT REGENT (OUTLET)
BC-2B
SPT Blows/ft 845.5
CL Dk brn, moist, silty
ML-SC Dk yellow brn, moist, silty
SP Blk, f-m sand, wet
SP-SW M-C sand, wet
827.5
APPROX 80' ALONG LEFTBANK (LOOKING DOWNSTREAM)
APPROX 80' ALONG RIGHT BANK
TOP OF BANK RIPRAP PROTECTION EL 838.0
FLOW
154"X97" RCPA
12" MIN. MnDOT TYPE I FILTER BLANKET
18" MIN. MnDOT CLASS A RIPRAP
SECTION: RIPRAP AT REGENT (INLET)
SCALE 1"=10'-0"
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA
BARR ENG CO.
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
CULVERT REPLACEMENT AT NOBLE & REGENT AVES
DATE AUGUST 1982
AS SHOWN
DRAWING NUMBER M34.3-R-5/202
SHEET 21 OF 44

PLATE 21



NORTH BR STA 42+60
CABLE GUARDRAIL
EXISTING 15" CMP WITH APRON (REMOVE)
SEE "DETAIL B"
PROTECT WATERMAIN AND INSULATE AS NECESSARY
34th AVE
HSE
FLOW
BORING BC-8A
REMOVE EXISTING CONCRETE BOX CULVERT
GAR
Scale in feet
0 25 50 100
N
REMOVE PAVEM
RESTORE A
MAX 25'
TOP OF RIPRAP EL 863.0
SLOPE 1V TO 2H OR FLATTER TO CONFORM TO EXISTING SLOPE
12" MIN MnDOT TYPE 2 FILTER BLANKET (TYP)
36" MIN MnDOT CLASS C (MODIFIED) RIPRAP (TYP)
VARIES FROM 10' AT CULVERT TO WIDTH OF EXISTING CHANNEL 40' DOWNSTREAM
9/22 SECTION: RIPRAP AT 34TH (OUTLET)
SCALE 1" = 10'
TOP OF ROAD
NOTE RIPRAP BANK PROTECTION EXTENDS 20' UPSTREAM OF END OF APRON
TOP OF RIPRAP EL 861.0
1V TO 1-1/2 H (MAX)
1V TO 2H
12" MIN MnDOT TYPE 1 FILTER BLANKET (TYP)
18" MIN MnDOT CLASS A RIPRAP (TYP)
VARIES FROM 10' WIDE AT CULVERT APRON TO WIDTH OF EXISTING CHANNEL 20' UPSTREAM
8/22 SECTION: RIPRAP AT 34TH (INLET)
SCALE 1" = 10'
BC-8A
SPT Blows/Ft MC LL PL
879.0
CL Dk brn, silty, moist, trace s, grav, roots, fill
CL Dk olive brn, sandy, moist, fill
CL + ML
ML Olive-yell, clayey, moist, some s, grav, fill
GC
-wet
CL-ML Dk gray-brn, moist
17 14
-wet
Dk gray-brn, silty, till, moist
CL
842.5
880 870 860 850 840
RIPRAP
TOP OF RIPRAP ALONG BANKS
40'
FLOW
115" x 72" RCPA
857.7
857.8
12" MIN MnDOT TYPE 2 FILTER BLANKET
36" MIN MnDOT CLASS C(MODIFIED) RIPRAP
10/22 SECTION: RIPRAP AT 34TH (OUTLET)
SCALE 1" = 10'
DESIGN WATER SURFACE EL 870.0
FINAL GRADE OVER PIPE
FINAL GRADE OVER PIPE
DESIGN WATER SURFACE EL 864.3
134 LF 115" x 72" RCPA CL 118 AT 0.22% INCLUDING MITERED APRONS
EXISTING 10" VCP SANITARY SEWER LOCATE SANITARY SEWER AT CULVERT (INCIDENTAL) AND INSULATE WITH POLYSTYRENE BOARD
17 LF 12" RCP CL 11 AT 1.00%
30 LF 12" RCP CL 11 AT 1.00%
874.0
874.0
NOTE: STA REFERENCED TO ℄ 115" x 72" RCPA
DETAIL "B"
890 880 870 860 850
2+00 3+00 4+00 5+00
Scale in feet
618 CONCRETE C & G (TYP)
1/22 SECTION C

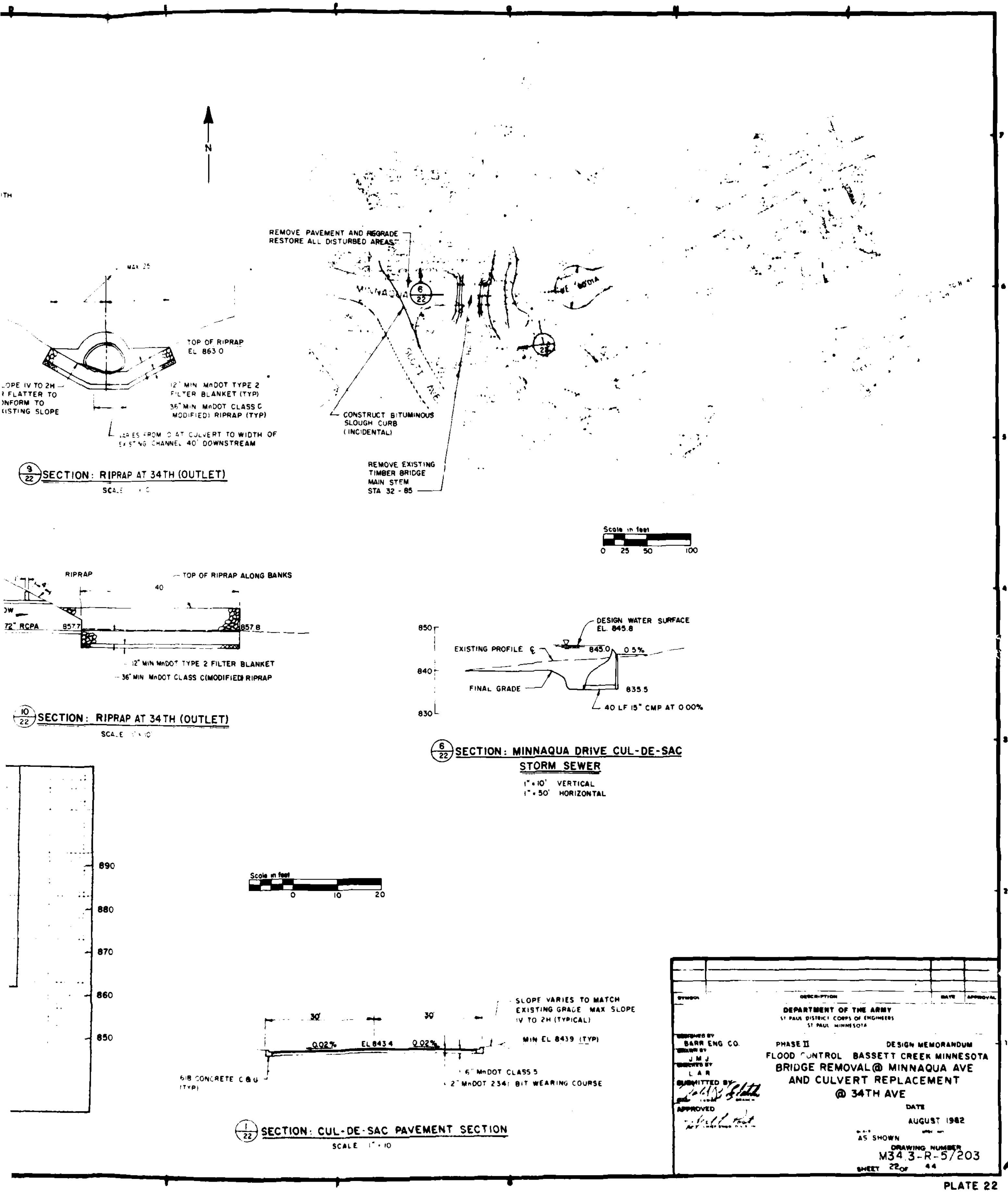
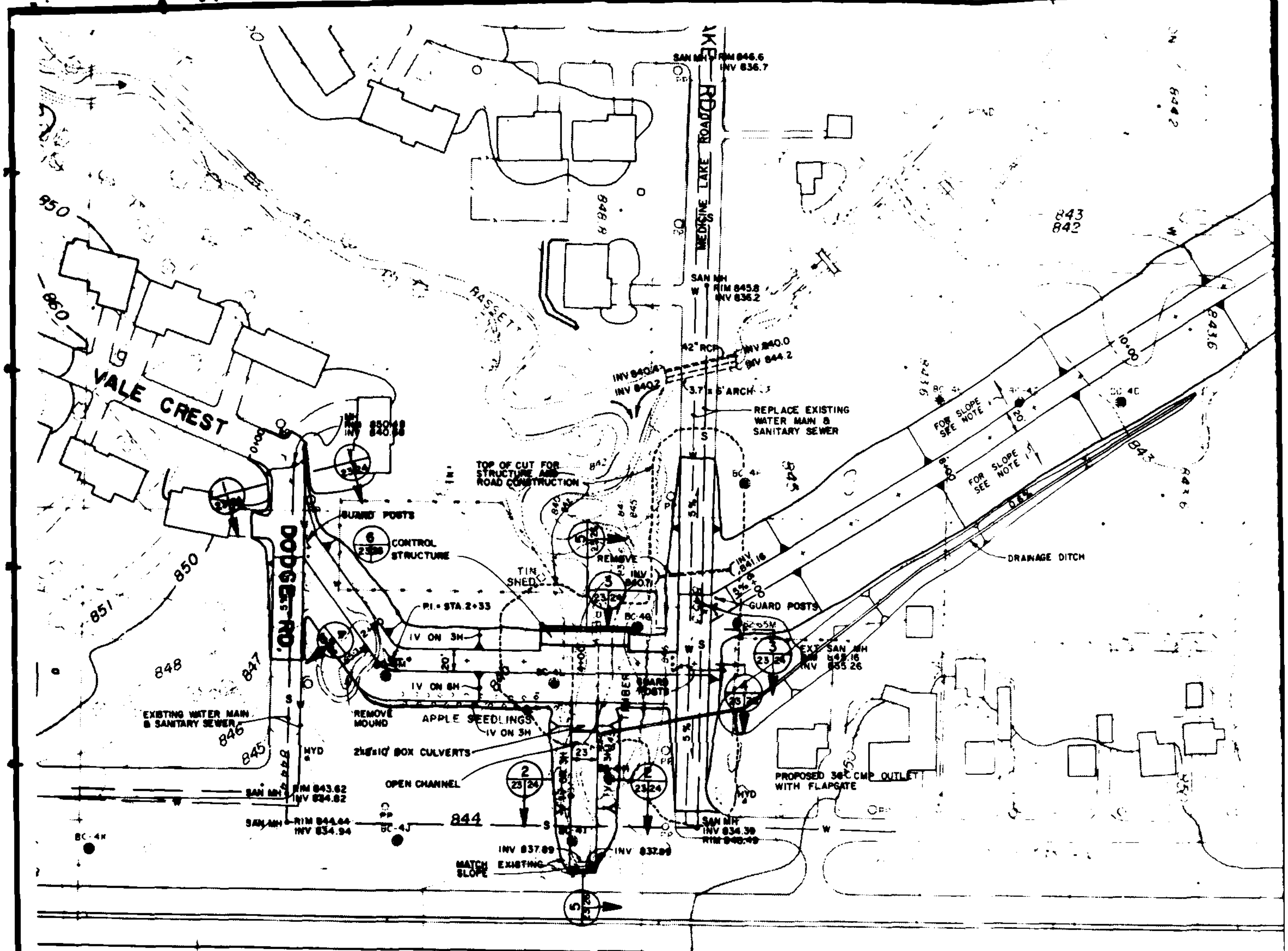
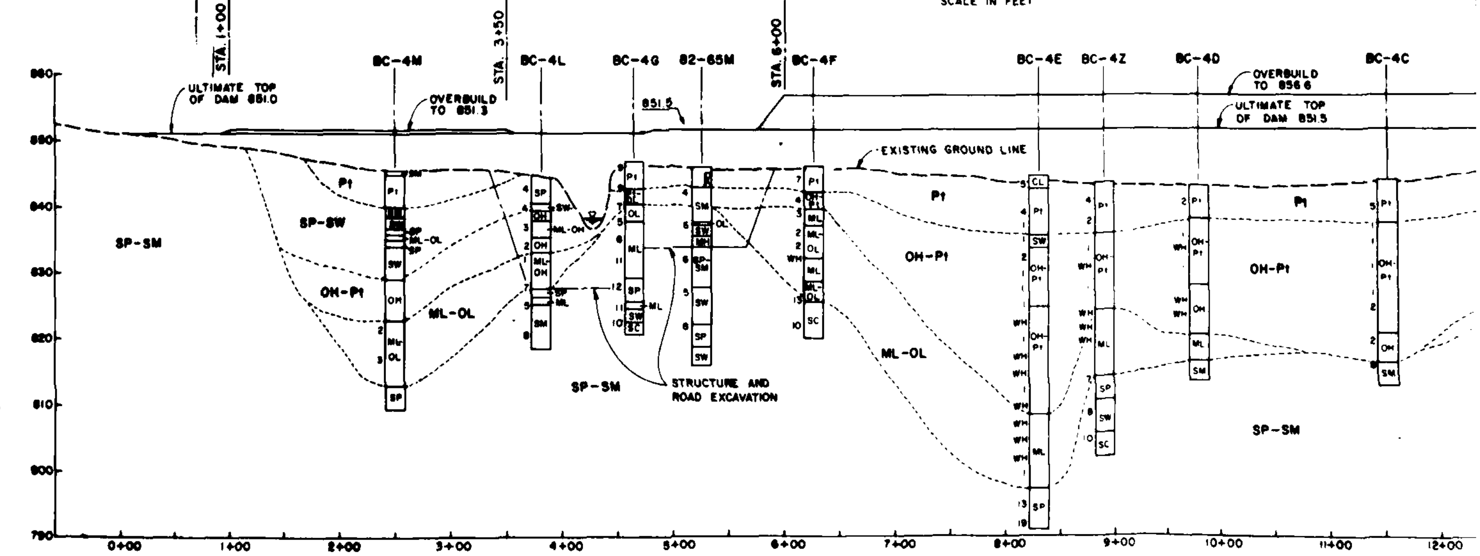

N
REMOVE PAVEMENT AND REGRADE
RESTORE ALL DISTURBED AREAS
MINNAQUA
6/22
1/22
CONSTRUCT BITUMINOUS SLOUGH CURB (INCIDENTAL)
REMOVE EXISTING TIMBER BRIDGE MAIN STEM STA 32 - 85
Scale in feet
0 25 50 100
TOP OF RIPRAP EL 863.0
12" MIN MnDOT TYPE 2 FILTER BLANKET (TYP)
36" MIN MnDOT CLASS C MODIFIED) RIPRAP (TYP)
9/22 SECTION: RIPRAP AT 34TH (OUTLET)
RIPRAP
TOP OF RIPRAP ALONG BANKS
40
72" RCPA
857.7
857.8
12" MIN MnDOT TYPE 2 FILTER BLANKET
36" MIN MnDOT CLASS C(MODIFIED) RIPRAP
10/22 SECTION: RIPRAP AT 34TH (OUTLET)
850
840
830
DESIGN WATER SURFACE EL. 845.8
EXISTING PROFILE ℄
845.0
0.5%
FINAL GRADE
835.5
40 LF 15" CMP AT 0.00%
6/22 SECTION: MINNAQUA DRIVE CUL-DE-SAC STORM SEWER
1" = 10' VERTICAL
1" = 50' HORIZONTAL
890
880
870
860
850
Scale in feet
0 10 20
SLOPE VARIES TO MATCH EXISTING GRADE MAX SLOPE 1V TO 2H (TYPICAL)
30'
30'
0.02%
EL 843.4
0.02%
MIN EL 843.9 (TYP)
618 CONCRETE C & G (TYP)
6" MnDOT CLASS 5
2" MnDOT 2341 BIT WEARING COURSE
1/22 SECTION: CUL-DE-SAC PAVEMENT SECTION
SCALE 1" = 10
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA
BARR ENG CO.
J M J
L A R
SUBMITTED BY
APPROVED
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
BRIDGE REMOVAL @ MINNAQUA AVE
AND CULVERT REPLACEMENT
@ 34TH AVE
DATE
AUGUST 1982
AS SHOWN
DRAWING NUMBER
M34.3-R-5/203
SHEET 22 OF 44

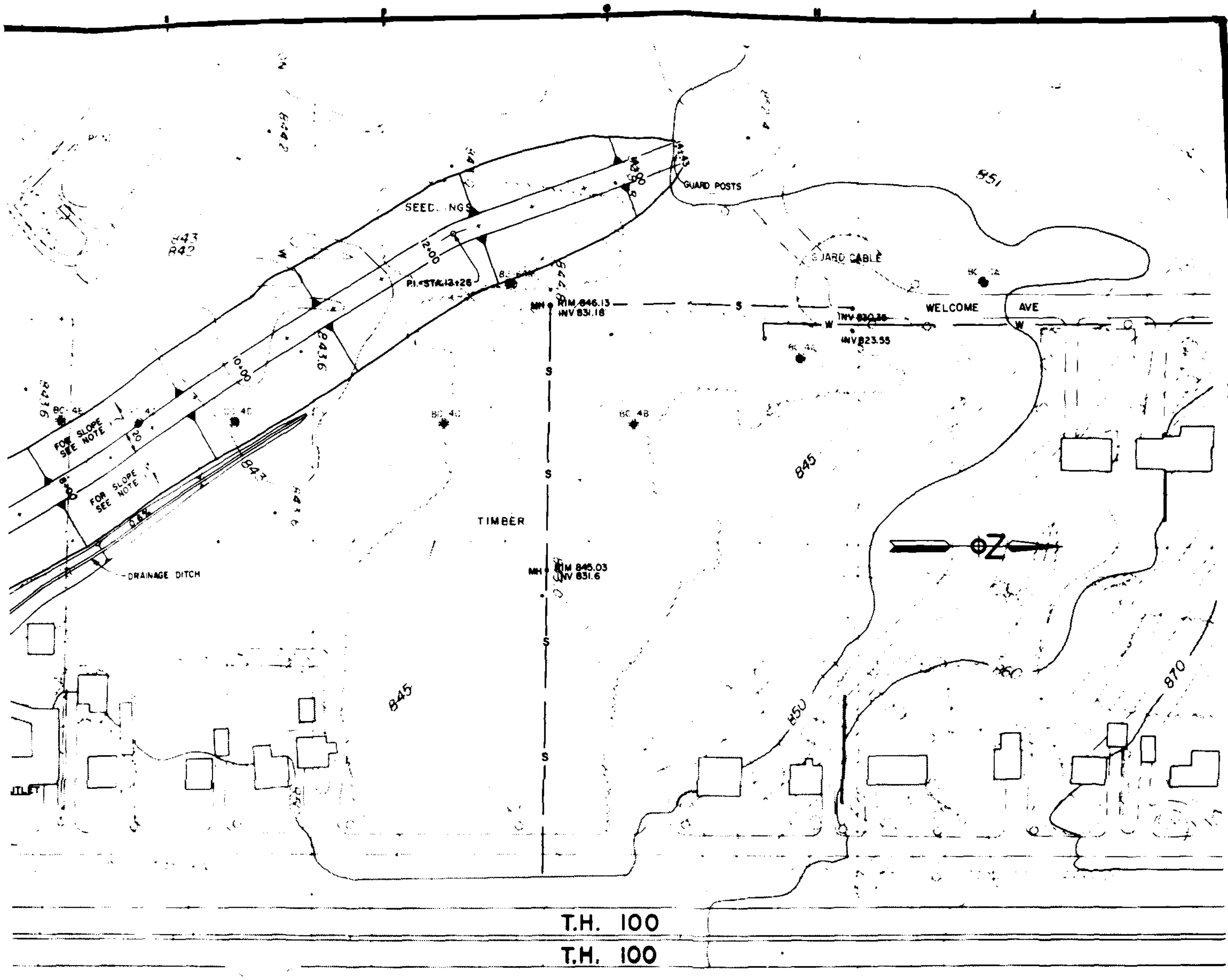
PLATE 22

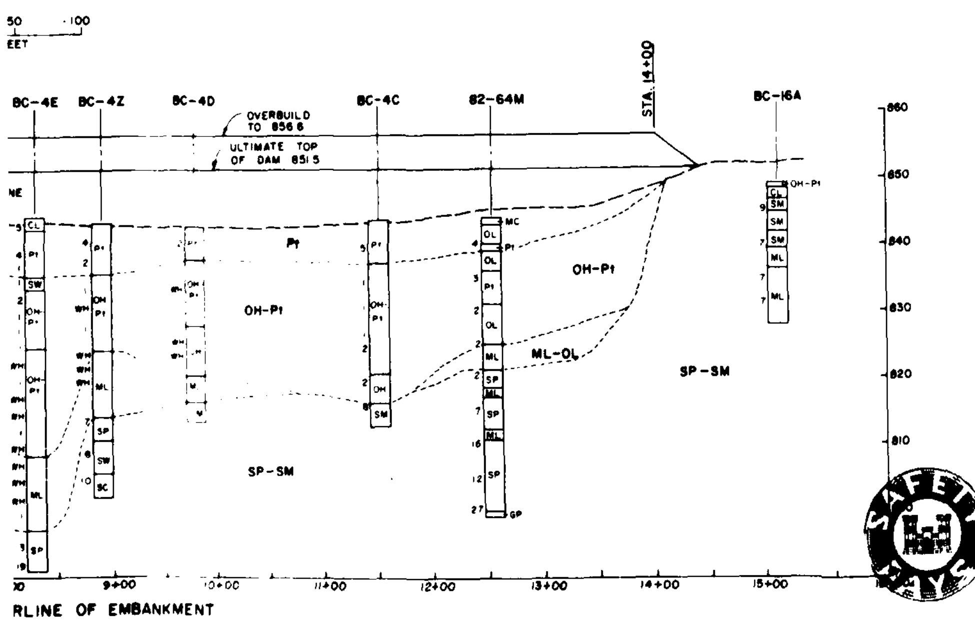


PLAN
SCALE IN FEET



PROFILE ALONG CENTERLINE OF EMBANKMENT





NOTES:

1. Due to large amounts of settlement upstream slope will change from 1 V on 3 H at End to Construction to 1 V on 4.75 H after 100 years of secondary consolidation. likewise the downstream slop will vary from 1 V on 3.7 H to 1 V on 6 H.
2. The embankment from Sta. 6 + 00 to 14 + 00 will be constructed in three stages over a two year period. (See Sheet 26)
3. The numbers to the left of the boring columns are standard blows per foot.
4. Detailed Boring logs are shown on Sheet C-13
5. For typical sections See Sheet 26

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

D.W.R.
W.J.V.
M.B.
SUBMITTED BY:
APPROVED:

PHASE II — DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
HIGHWAY 100 EMBANKMENT
PLAN AND PROFILE

DATE: AUGUST 1962

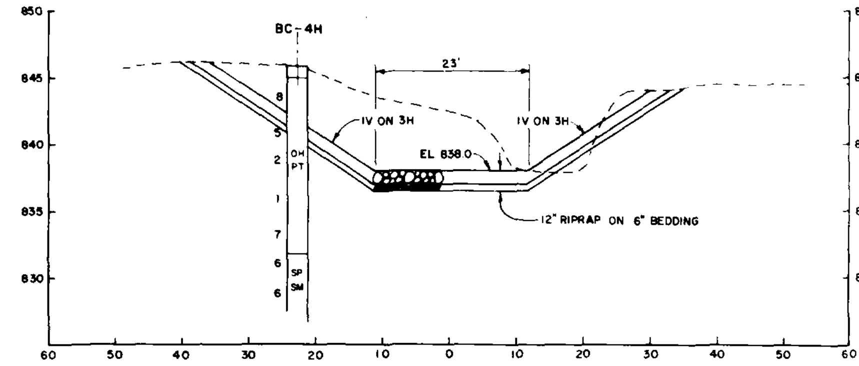
SCALE: AS SHOWN

DRAWING NUMBER M34.3-R-5/204

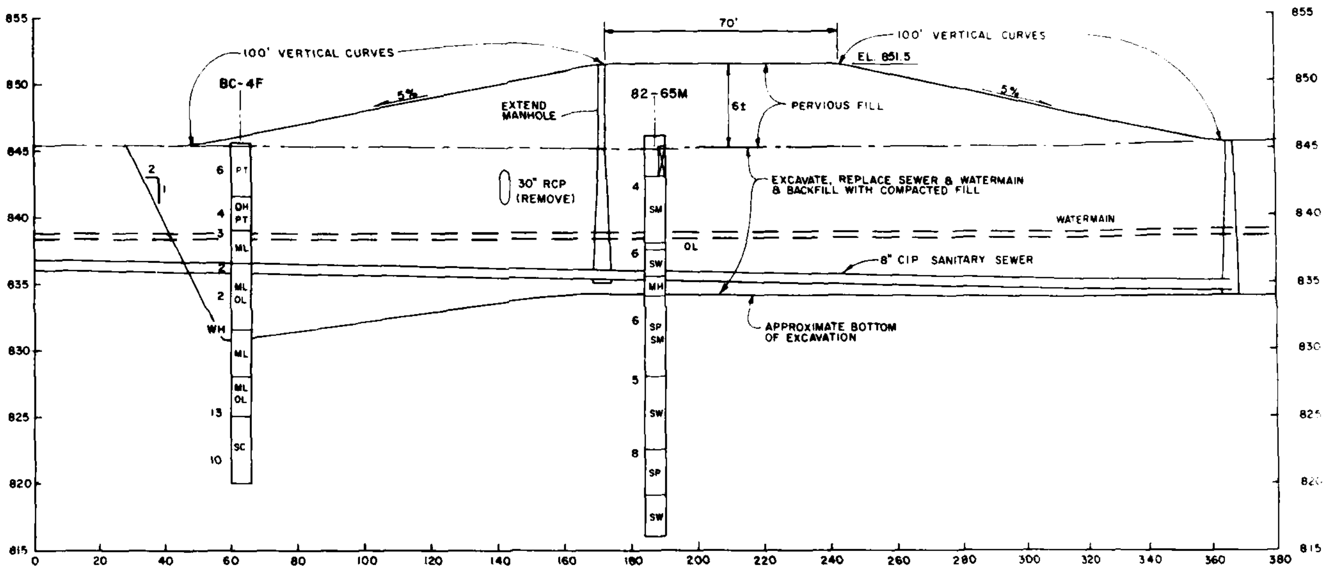
SHEET 23 OF 44

PLATE 23

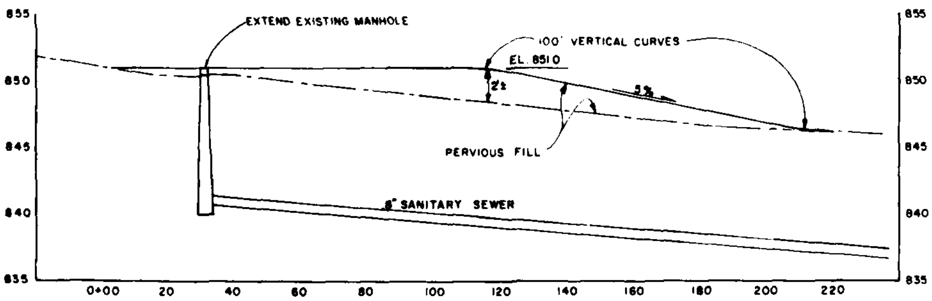
2



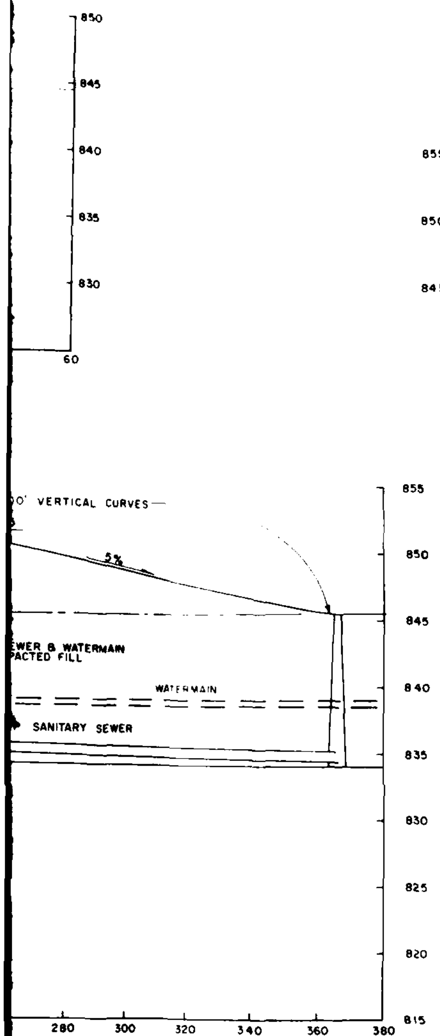
TYPICAL SECTION 2/2324



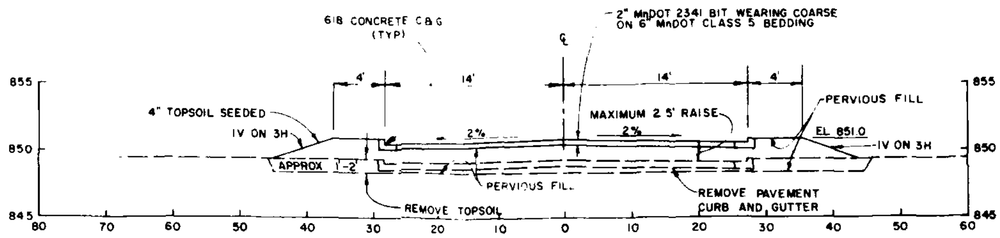
PROFILE ALONG MEDICINE LAKE ROAD CENTERLINE



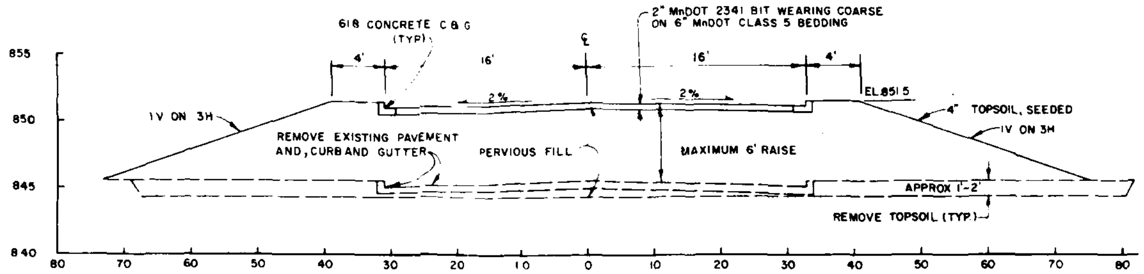
PROFILE ALONG DODGE ROAD CENTERLINE



LINE



TYPICAL SECTION 1 23|24
DODGE ROAD RAISE



TYPICAL SECTION 3 23|24
MEDICINE LAKE ROAD
EMBANKMENT

SAFETY PAYS

SYMBOL	DESCRIPTION	DATE	APPROVAL

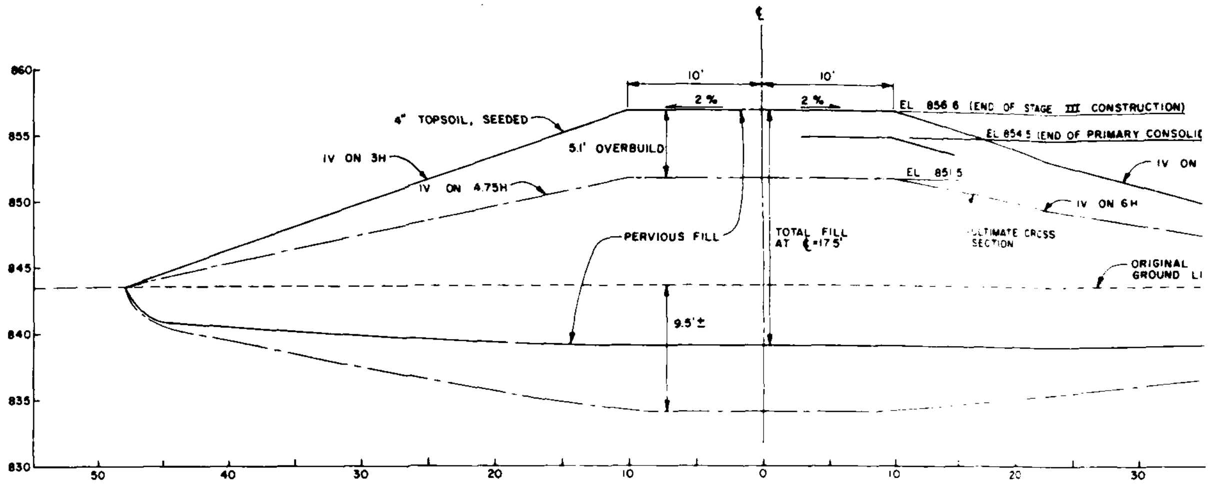
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: D W R
DRAWN BY: J M J
CHECKED BY: M B.
SUBMITTED BY:
APPROVED:

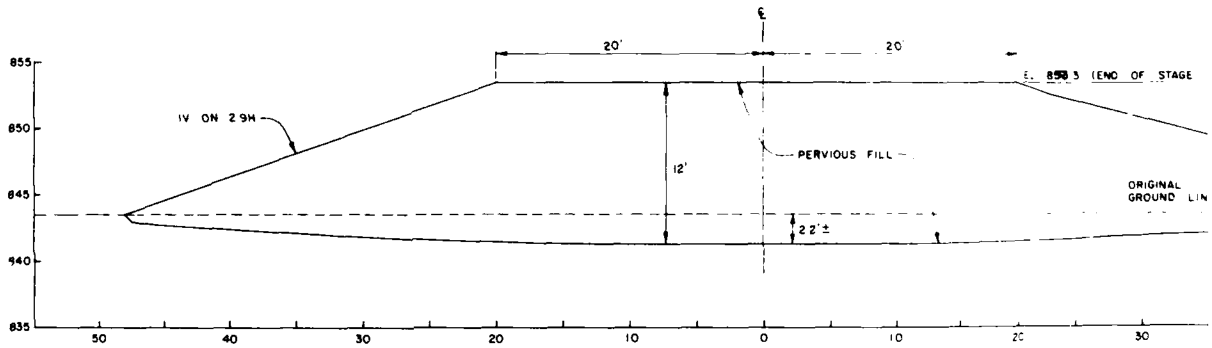
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
HIGHWAY 100 EMBANKMENT
PROFILES AND SECTIONS

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34 3-R-57205
SHEET 24 OF 44

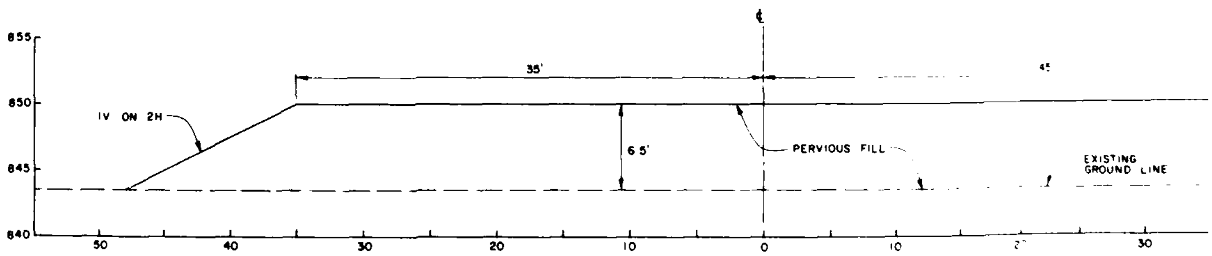
PLATE 24



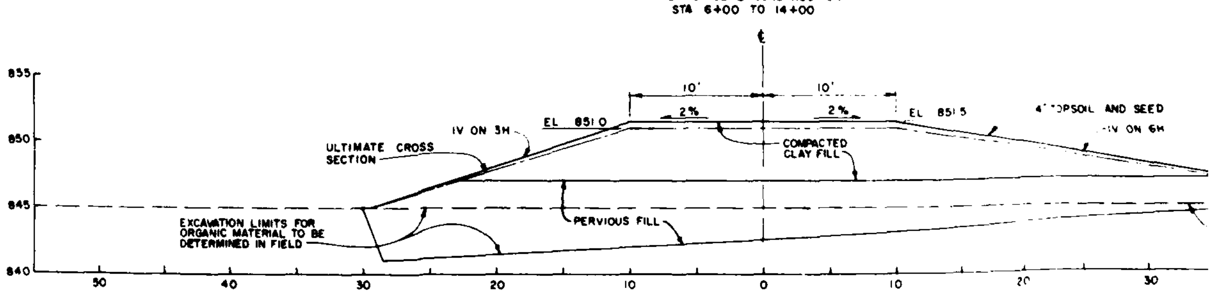
TYPICAL SECTION
AFTER STAGE III CONSTRUCTION
STA 6+00 TO 14+00



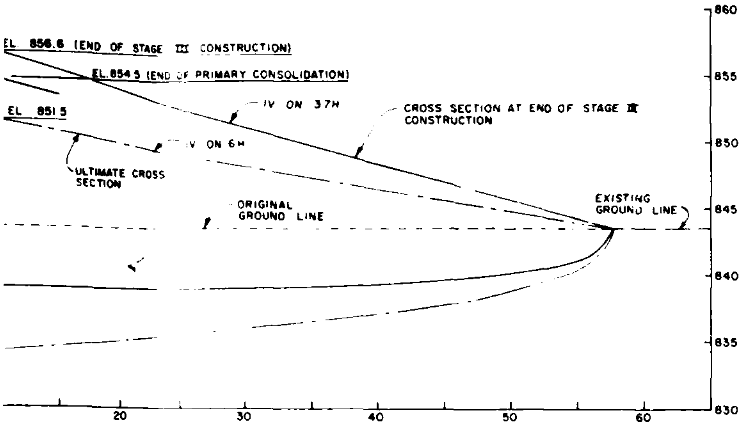
TYPICAL SECTION
AFTER STAGE II CONSTRUCTION
STA 6+00 TO 14+00

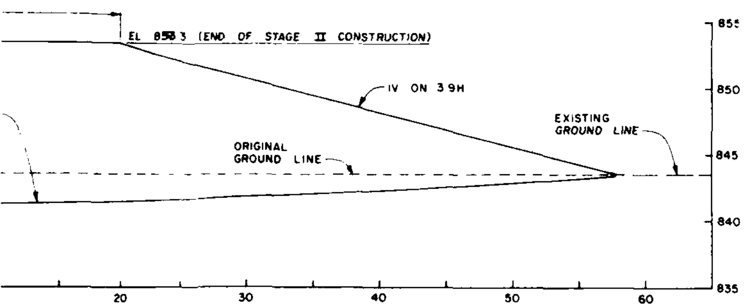


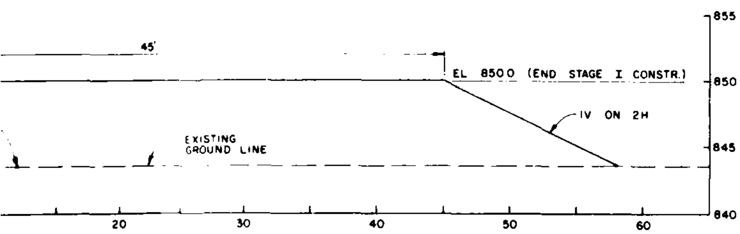
TYPICAL SECTION
AFTER STAGE I CONSTRUCTION
STA 6+00 TO 14+00

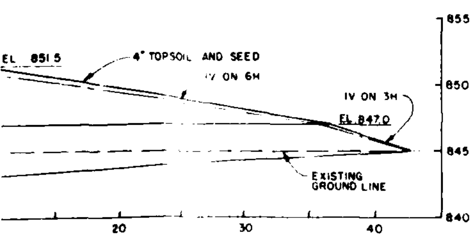


TYPICAL SECTION
STA 1+00 TO 4+75









DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

D.W.R.
W J V
M B
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

HIGHWAY 100 EMBANKMENT

TYPICAL SECTIONS

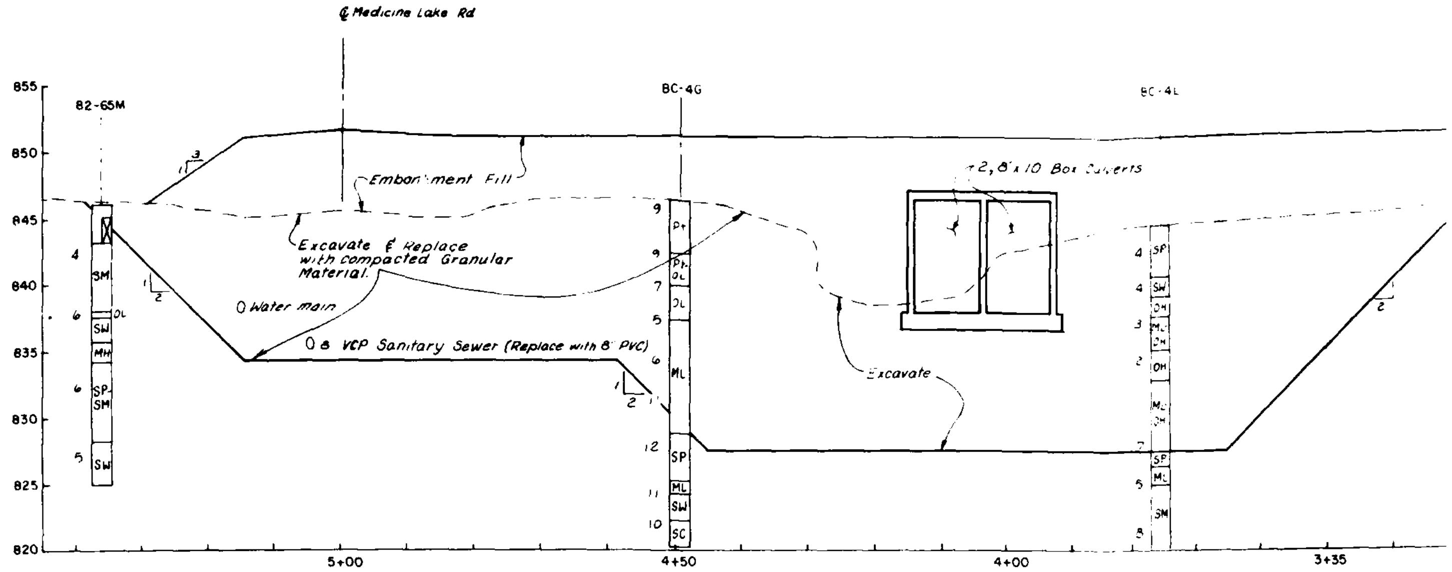
DATE: AUGUST 1982

AS SHOWN

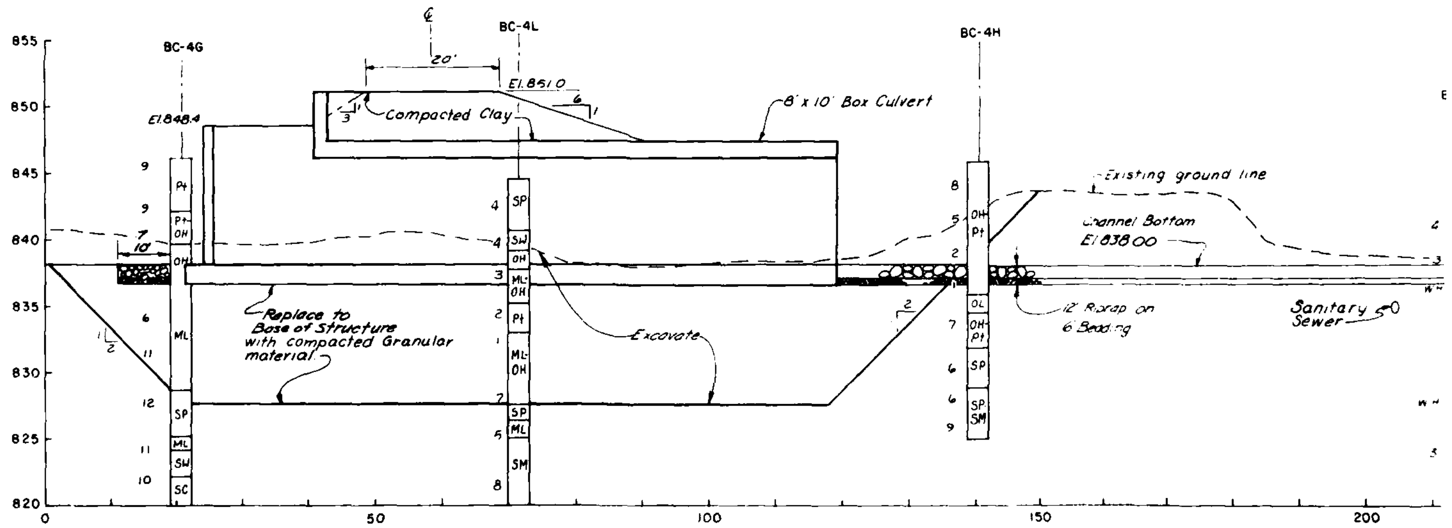
DRAWING NUMBER M34.3-R-5/206

SHEET 25 OF 44

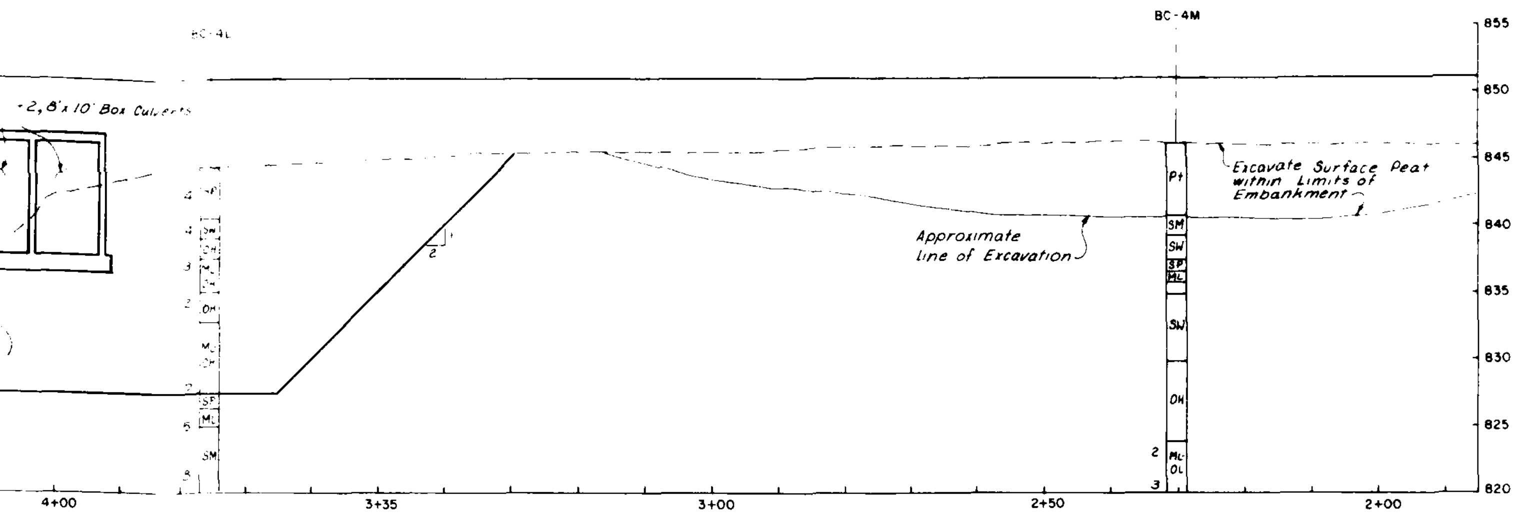
PLATE 25



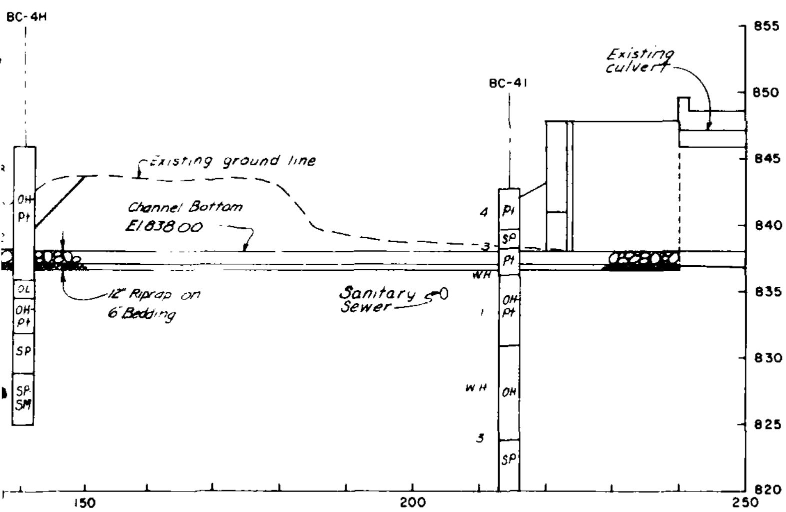
EMBANKMENT PROFILE 4/23|26
STA 1+85 TO 5+00



CONDUIT PROFILE 5/23|26



EMBANKMENT PROFILE (4 / 23 26)
STA 1+85 TO 5+00



(5 / 23 26)

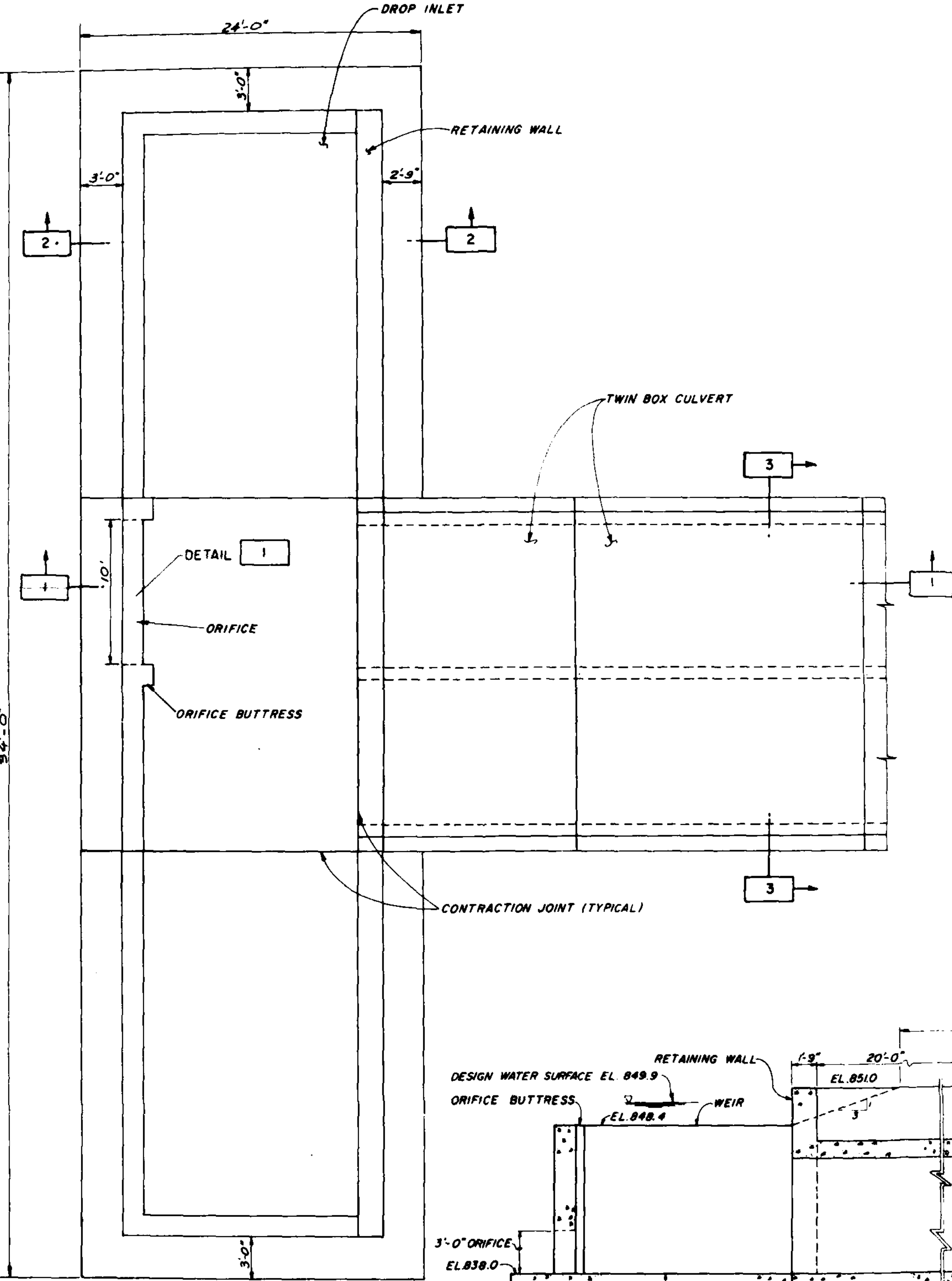
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DWR
PW
MB
SUBMITTED BY:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
HIGHWAY 100 EMBANKMENT
EXCAVATION SECTION & CONDUIT PROFILE

APPROVED
DATE: AUGUST 1982
AS SHOWN
DRAWING NUMBER
M34 3-R-5/207
SHEET 26 OF 43

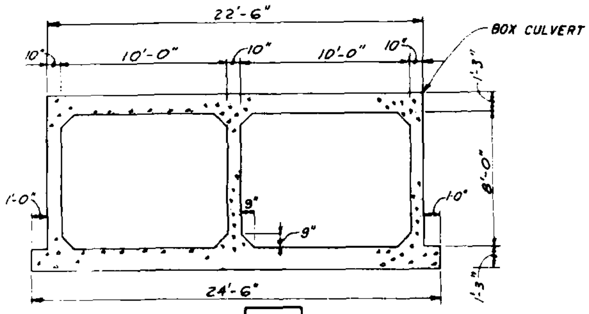
PLATE 26



6/23 27 CONTROL STRUCTURE PLAN

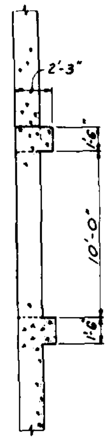
SECTION 1

4 0 4
SCALE IN FEET



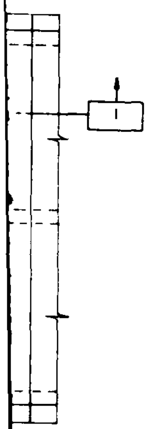
SECTION 3

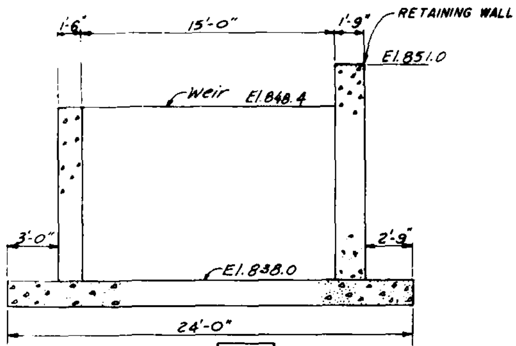
TWIN BOX CULVERT



DETAIL 1

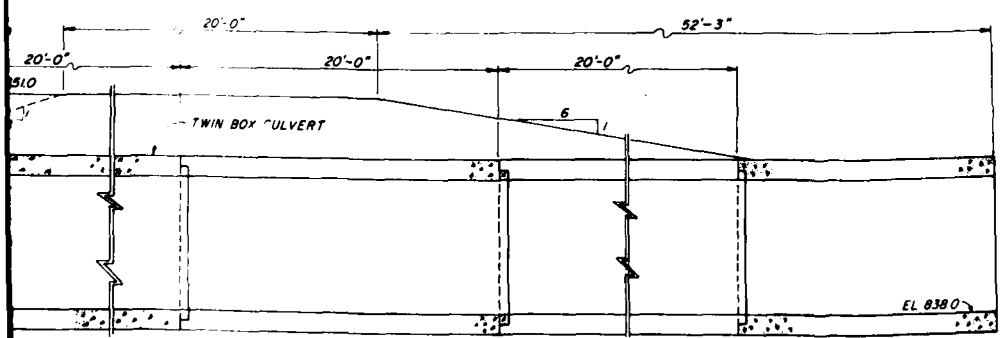
ORIFICE BUTTRESS





SECTION 2

WEIR AND RETAINING WALL



SECTION 1

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: BARR ENGR. & GLC
CHECKED BY: LAR
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
HIGHWAY 100 CONTROL STRUCTURE
PLAN AND SECTIONS

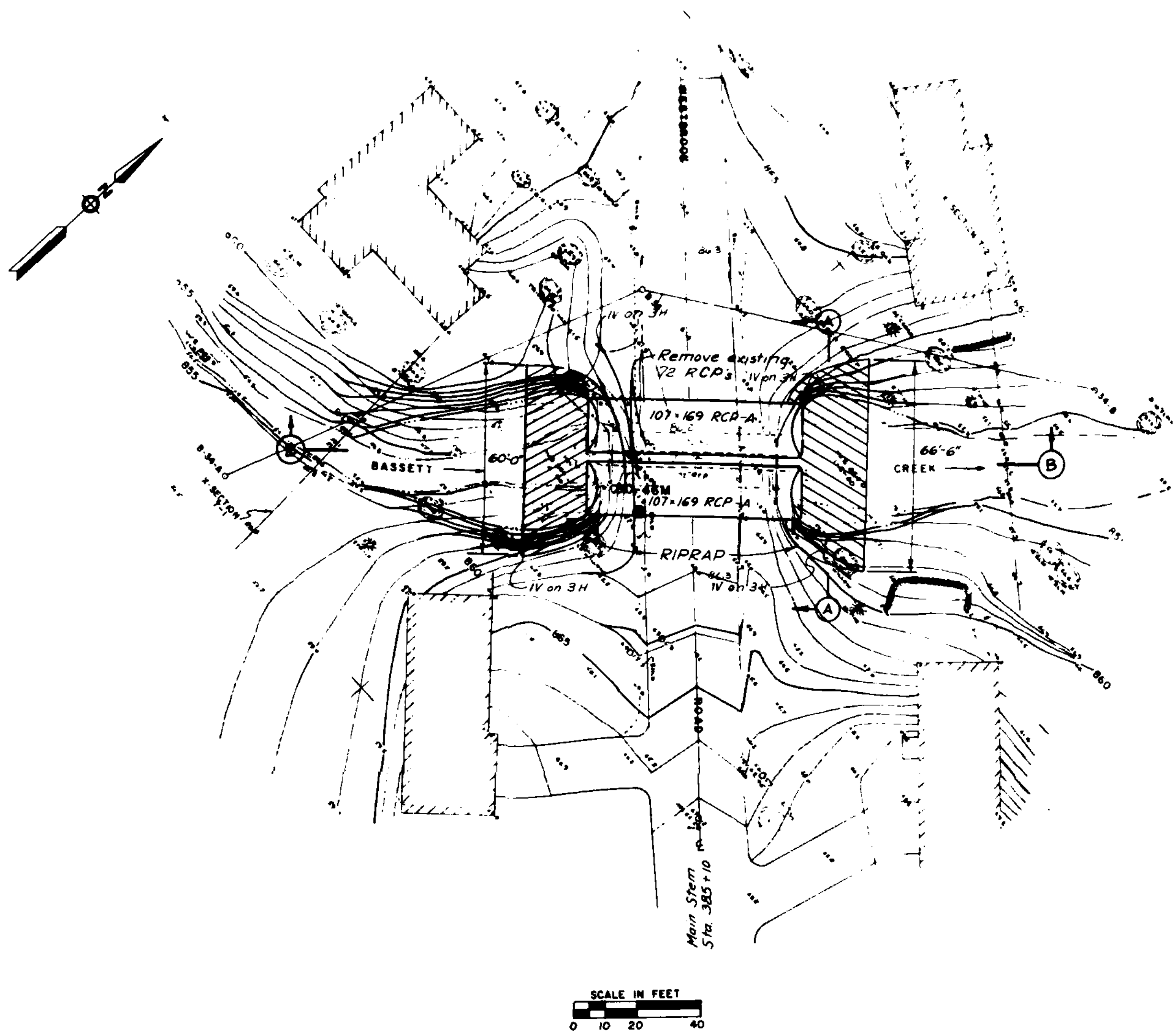
DATE: AUGUST 1982

SCALE: AS SHOWN

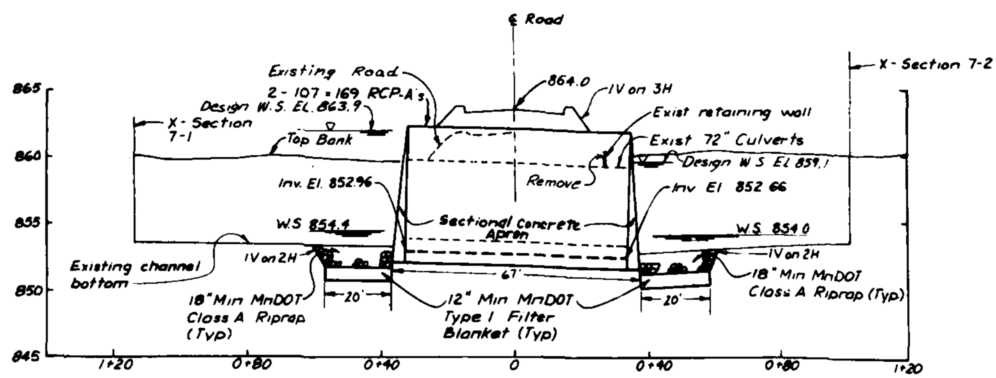
DRAWING NUMBER: M34.3-R-57208

SHEET 27 OF 44

PLATE 27

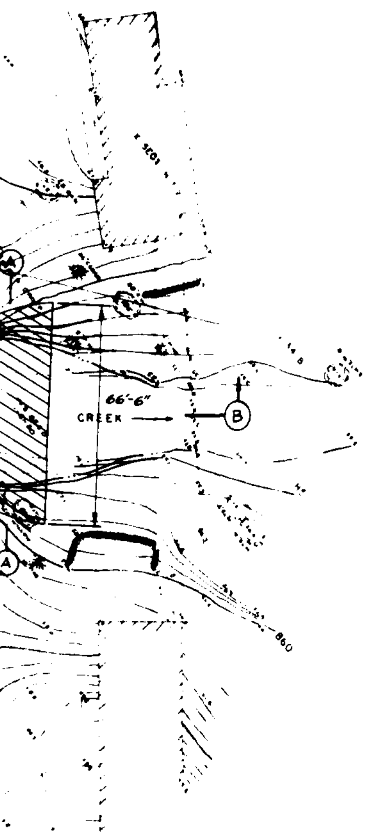


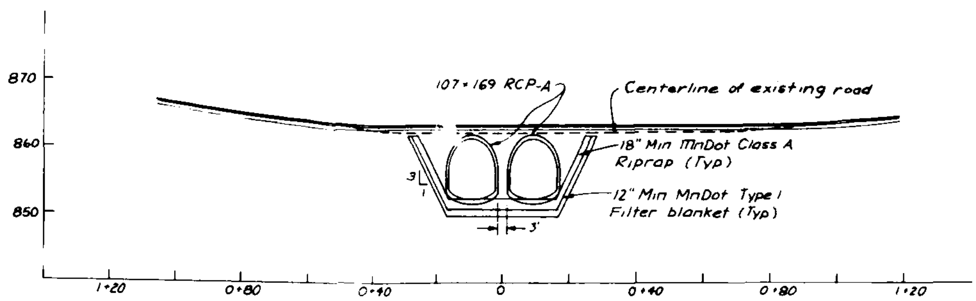
Remove existing
2 RCP's
1V on 3H
107 × 169 RCP-A
107 × 169 RCP-A
BASSETT
CREEK
60'-0"
66'-6"
RIPRAP
1V on 3H
Main Stem
Sta. 385+10
ROAD
SCALE IN FEET
0 10 20 40



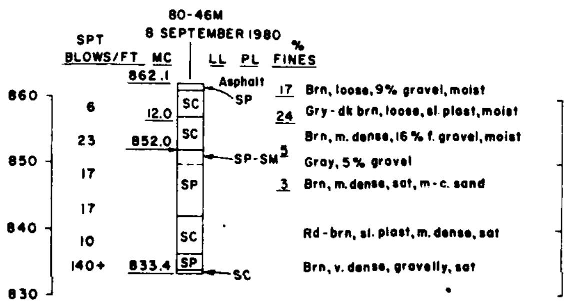
℄ Road
Existing Road
2 - 107 × 169 RCP-A's
864.0
1V on 3H
X - Section 7-2
Design W.S. EL. 863.9
X - Section 7-1
Top Bank
Exist retaining wall
Exist 72" Culverts
Design W S EL 859.1
Remove
Inv. El. 852.96
Inv El 852.66
Sectional Concrete Apron
W.S 854.4
W.S 854.0
1V on 2H
1V on 2H
Existing channel bottom
67'
20'
20'
18" Min MnDOT Class A Riprap (Typ)
12" Min MnDOT Type I Filter Blanket (Typ)
18" Min MnDOT Class A Riprap (Typ)
865
860
855
850
845
1+20
0+80
0+40
0
0+40
0+80
1+20

SECTION B-B



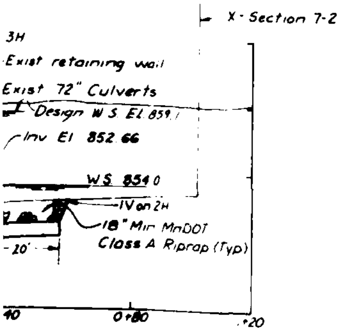


SECTION A-A



NOTE:

1. Pipe bedding shall be class A.
2. 107 x 169 RC pipe shall be class III A
3. Boring Legend shown on Plate C-11.



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: LAR
DRAWN BY: JGJ
CHECKED BY: LAR
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM

FLOOD CONTROL BASSETT CREEK MINNESOTA

CULVERT REPLACEMENT @ WESTBROOK RD

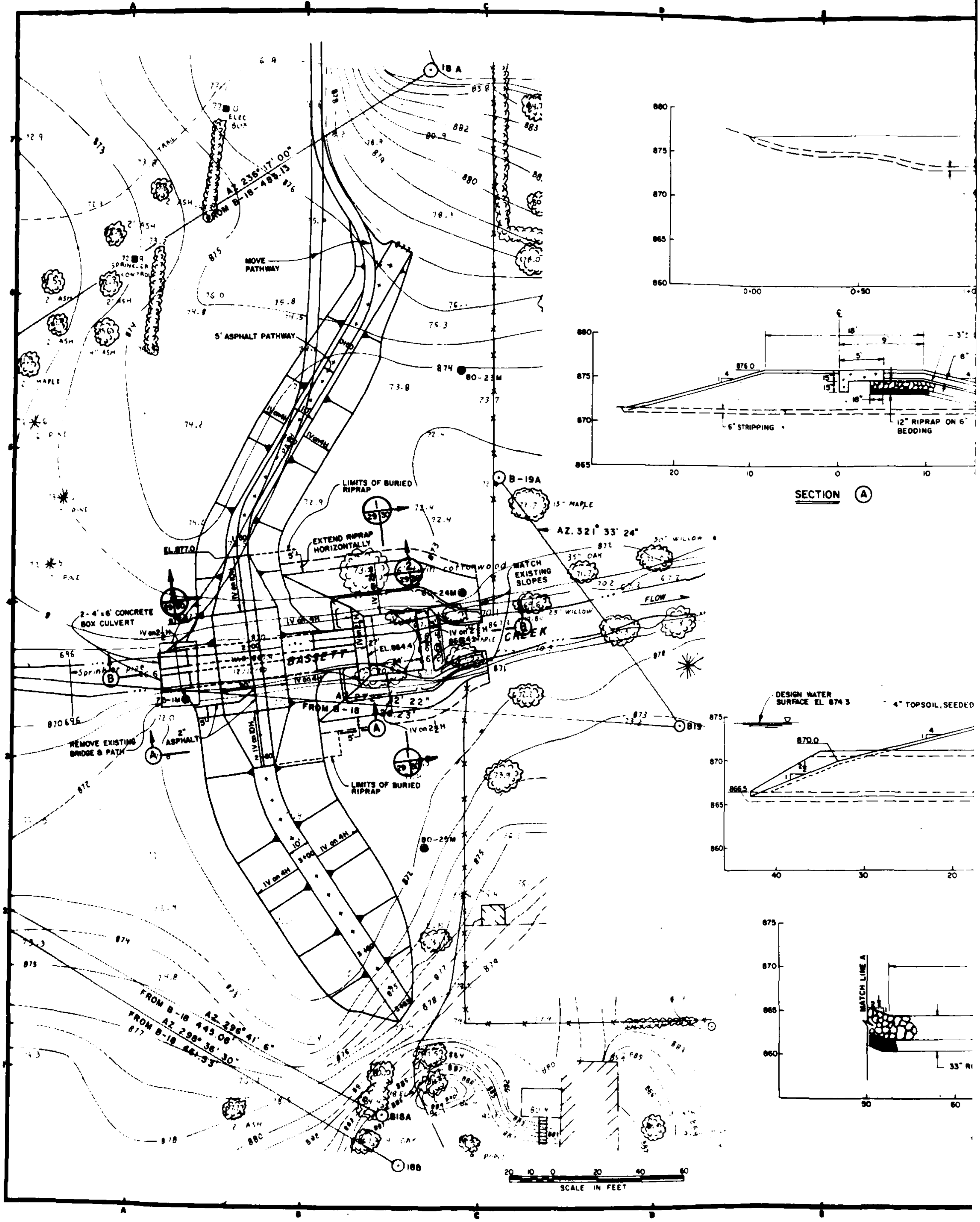
DATE: AUGUST 1982

SCALE: AS SHOWN

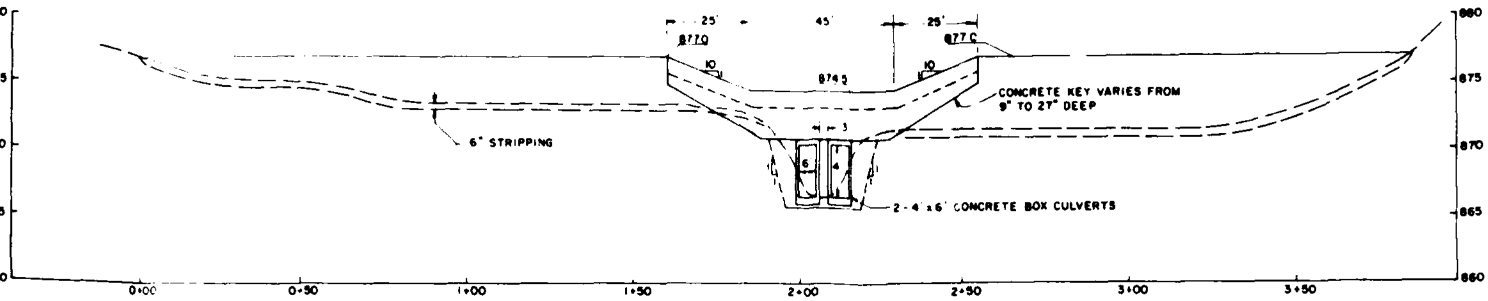
DRAWING NUMBER M34.3-R-5/210

SHEET 28 OF 44

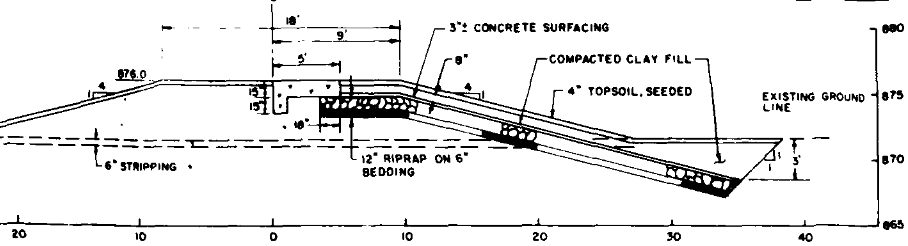
PLATE 28



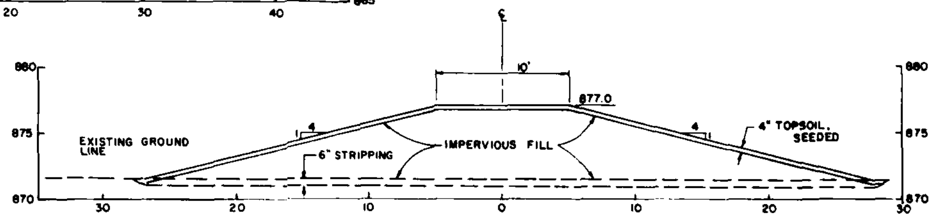
MOVE PATHWAY
5' ASPHALT PATHWAY
LIMITS OF BURIED RIPRAP
EXTEND RIPRAP HORIZONTALLY
MATCH EXISTING SLOPES
EL 877.0
2 - 4' x 6' CONCRETE BOX CULVERT
BASSETT
CREEK
FLOW
EL 864.4
REMOVE EXISTING BRIDGE & PATH
2" ASPHALT
AZ. 236° 17' 00"
FROM B-18 - 489.13
AZ. 321° 33' 24"
FROM B-18 445.08'
AZ. 296° 41' 6"
AZ. 298° 36' 30"
FROM B-18 461.33'
B-19A
B19
18 A
B18A
188
80-23M
80-24M
80-25M
75-1M
SCALE IN FEET
SECTION A
6" STRIPPING
12" RIPRAP ON 6" BEDDING
DESIGN WATER SURFACE EL 874.3
4" TOPSOIL, SEEDED
MATCH LINE A



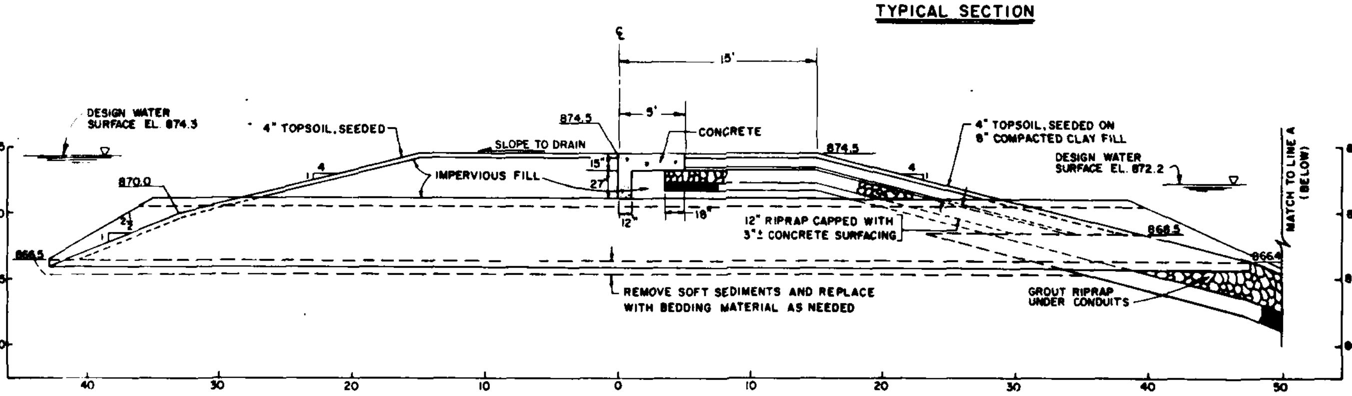
PROFILE ALONG CENTERLINE



SECTION (A)

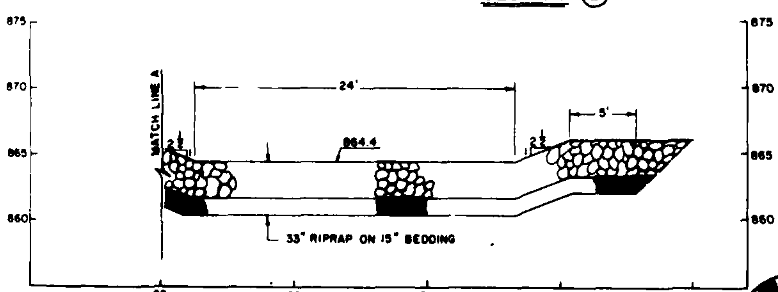


TYPICAL SECTION

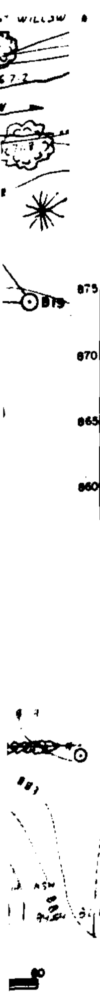


SECTION (B)

NOTE:
SEE SHEET 30 FOR DETAILED BORING LOGS

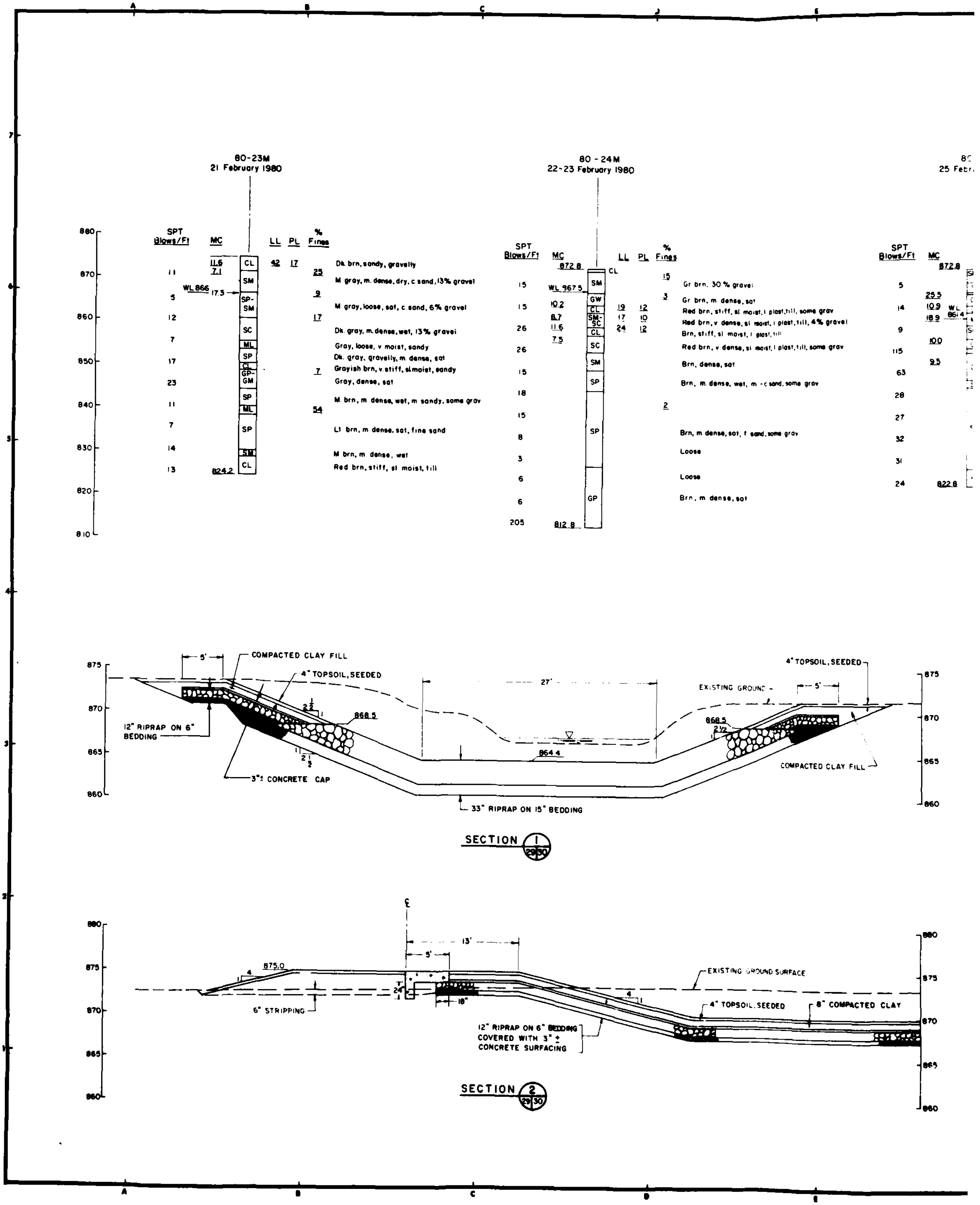


SECTION (B)

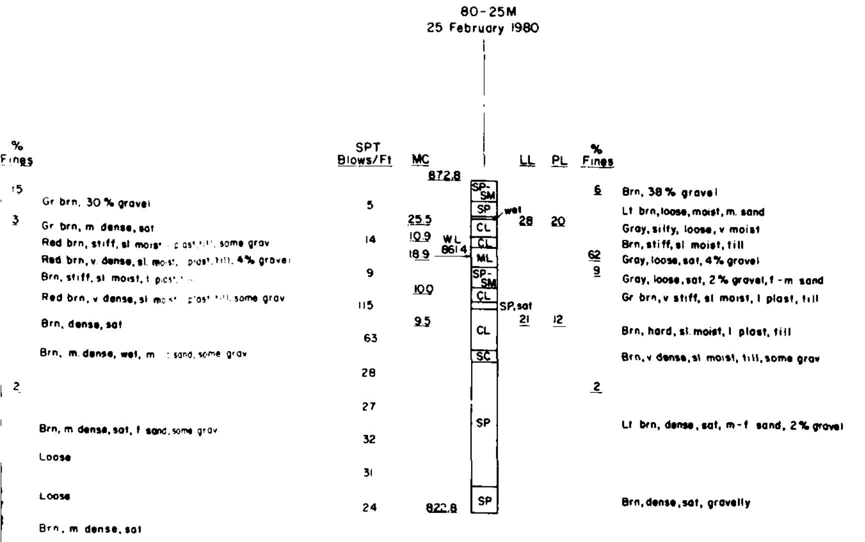


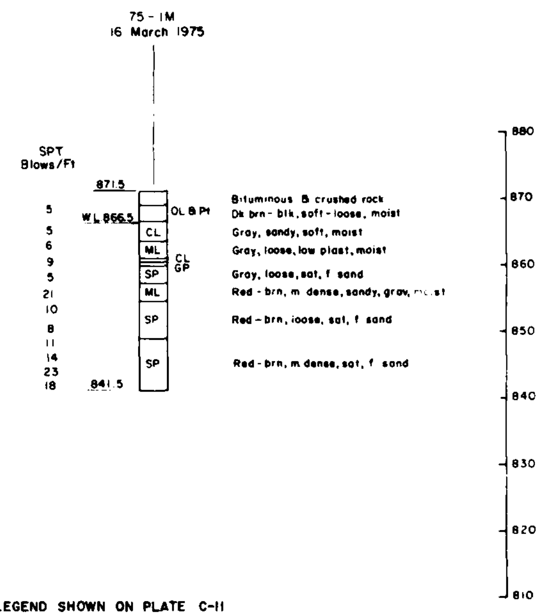
DEPARTMENT OF THE ARMY ST. PAUL DISTRICT, CORPS OF ENGINEERS ST. PAUL, MINNESOTA	
D.R., P.M.F.	PHASE II DESIGN MEMORANDUM FLOOD CONTROL BASSETT CREEK MINNESOTA
JGJ	GOLDEN VALLEY COUNTRY CLUB EMBANKMENT PLAN, PROFILE AND SECTIONS
M.B.	
SUBMITTED BY:	DATE: AUGUST 1982
APPROVED:	SCALE: AS SHOWN
	M34.3-R-57/211 SHEET 29 OF 44

PLATE 29



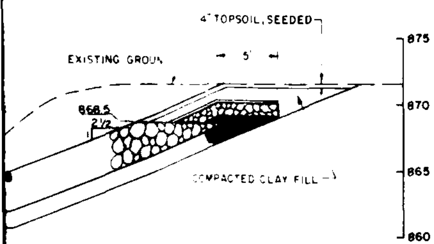
80-23M
21 February 1980
SPT Blows/Ft
MC
LL
PL
% Fines
Dk. brn, sandy, gravelly
M. gray, m. dense, dry, c. sand, 13% gravel
M. gray, loose, sat, c. sand, 6% gravel
Dk. gray, m. dense, wet, 13% gravel
Gray, loose, v. moist, sandy
Dk. gray, gravelly, m. dense, sat
Grayish brn, v. stiff, sl. moist, sandy
Gray, dense, sat
M. brn, m. dense, wet, m. sandy, some grav
Lt. brn, m. dense, sat, fine sand
M. brn, m. dense, wet
Red brn, stiff, sl. moist, till
80 - 24M
22-23 February 1980
Gr brn, 30% gravel
Gr brn, m. dense, sat
Red brn, stiff, sl. moist, l. plast, till, some grav
Red brn, v. dense, sl. moist, l. plast, till, 4% gravel
Brn, stiff, sl. moist, l. plast, till
Red brn, v. dense, sl. moist, l. plast, till, some grav
Brn, dense, sat
Brn, m. dense, wet, m.-c. sand, some grav
Brn, m. dense, sat, f. sand, some grav
Loose
Loose
Brn, m. dense, sat
25 Febr.
COMPACTED CLAY FILL
4" TOPSOIL, SEEDED
12" RIPRAP ON 6" BEDDING
3"± CONCRETE CAP
EXISTING GROUND
33" RIPRAP ON 15" BEDDING
SECTION 1 29 30
EXISTING GROUND SURFACE
6" STRIPPING
12" RIPRAP ON 6" BEDDING COVERED WITH 3" ± CONCRETE SURFACING
8" COMPACTED CLAY
SECTION 2 29 30

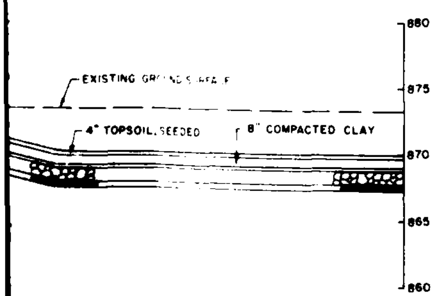




NOTE

BORING LEGEND SHOWN ON PLATE C-11





DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

D.R., P.M.F.
J.G.J.
M.B.
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

GOLDEN VALLEY COUNTRY CLUB EMBANKMENT

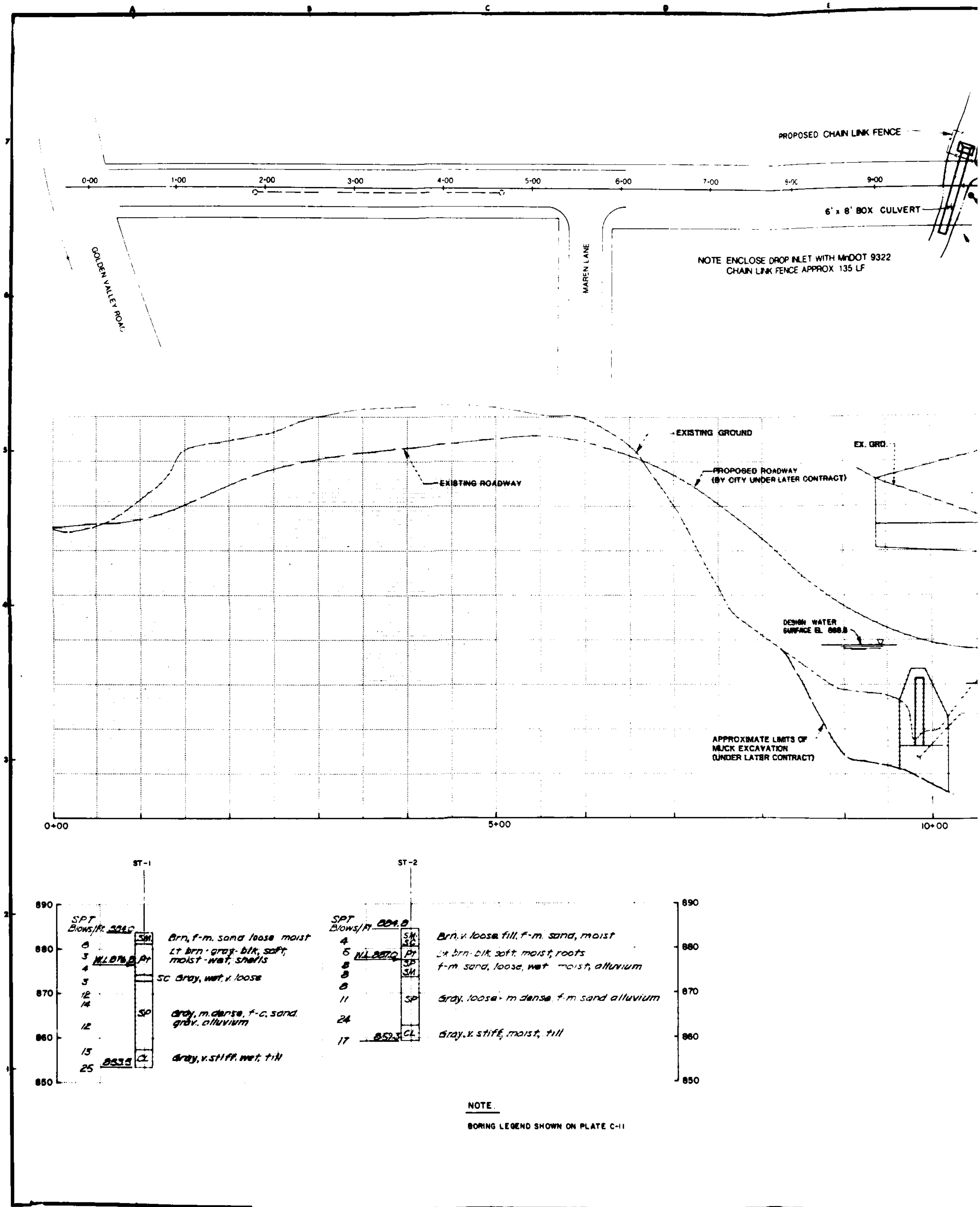
BORING LOGS AND SECTIONS

DATE: AUGUST 1982

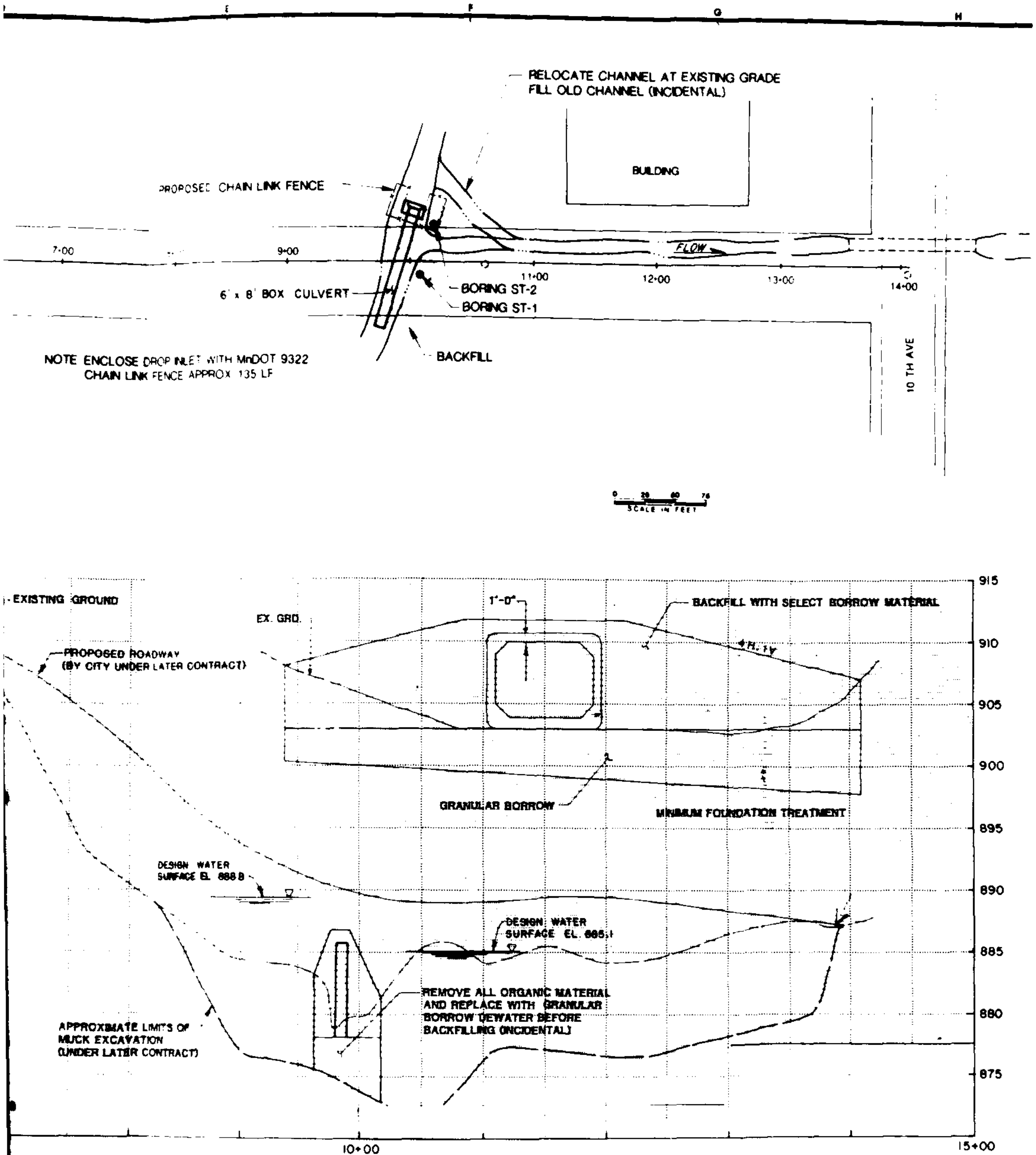
DRAWING NUMBER M34.3 R-5/212

SHEET 30 OF 44

PLATE 30



PROPOSED CHAIN LINK FENCE
0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
9+00
6' x 8' BOX CULVERT
NOTE ENCLOSE DROP INLET WITH MnDOT 9322 CHAIN LINK FENCE APPROX 135 LF
GOLDEN VALLEY ROAD
MAREN LANE
EXISTING GROUND
EX. GRD.
PROPOSED ROADWAY (BY CITY UNDER LATER CONTRACT)
EXISTING ROADWAY
DESIGN WATER SURFACE EL 868.8
APPROXIMATE LIMITS OF MUCK EXCAVATION (UNDER LATER CONTRACT)
0+00
5+00
10+00
ST-1
ST-2
SPT Blows/Ft. 884.0
Brn, f-m. sand loose moist
Lt brn - gray - blk, soft, moist - wet, shells
W.L. 876.8
SC Gray, wet, v. loose
Gray, m. dense, f-c. sand grav. alluvium
Gray, v. stiff, wet, till
853.5
SPT Blows/Ft. 884.8
Brn. v. loose fill, f-m. sand, moist
Lt brn - blk, soft, moist, roots
W.L. 887.0
f-m sand, loose, wet - moist, alluvium
Gray, loose - m. dense, f-m sand alluvium
Gray, v. stiff, moist, till
859.3
890
880
870
860
850
NOTE.
BORING LEGEND SHOWN ON PLATE C-11



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: BARR ENG CO
DRAWN BY: PW, JMJ
CHECKED BY: LAR

PHASE II
FLOOD CONTROL

DESIGN MEMORANDUM
BASSETT CREEK MINNESOTA

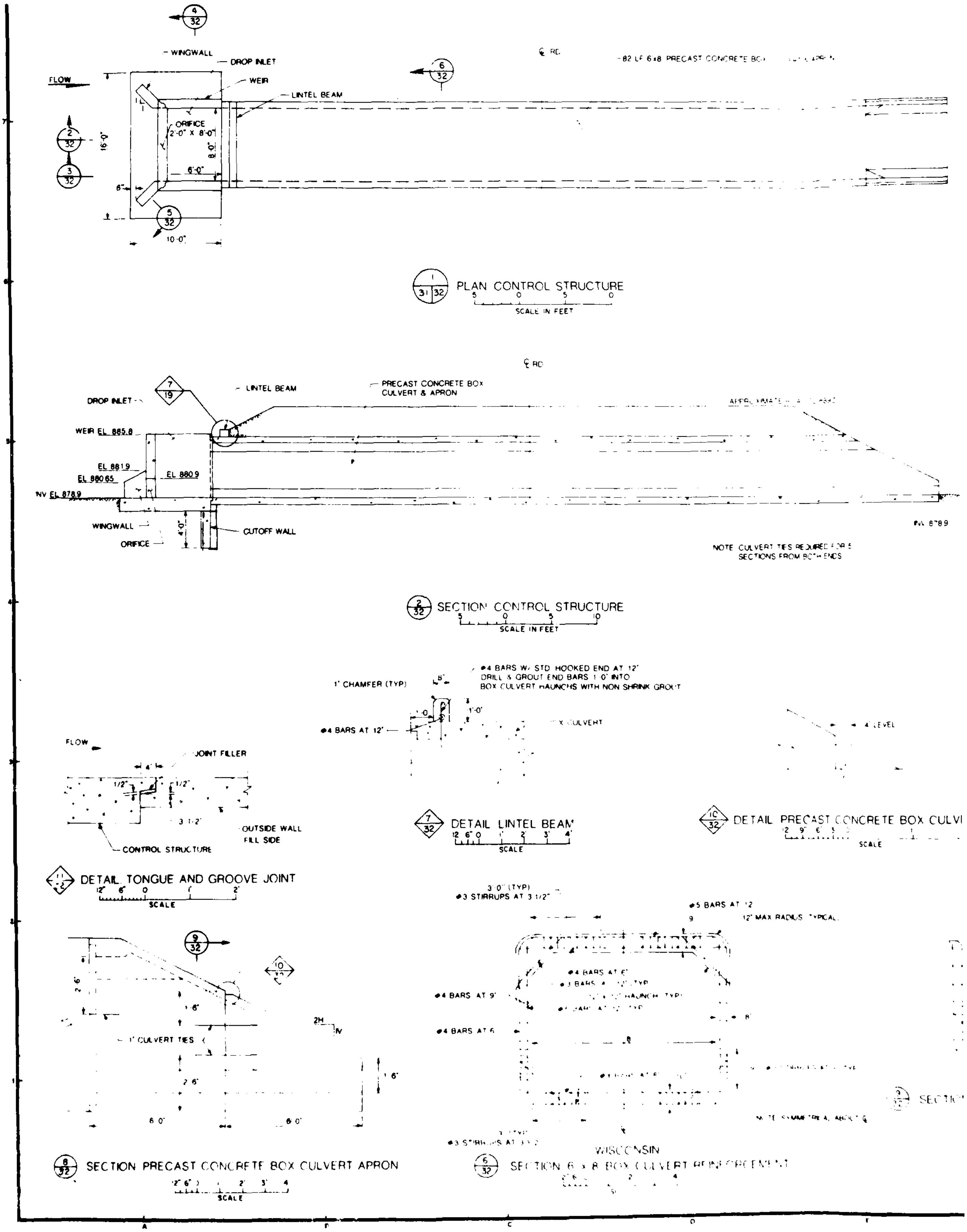
WISCONSIN AVE EMBANKMENT
PLAN AND PROFILE

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-5/213
SHEET 31 OF 44

2

PLATE 31

CORPS OF ENGINEERS



PLAN CONTROL STRUCTURE

SCALE IN FEET

SECTION CONTROL STRUCTURE

SCALE IN FEET

DETAIL TONGUE AND GROOVE JOINT

SCALE

DETAIL LINTEL BEAM

SCALE

DETAIL PRECAST CONCRETE BOX CULV

SCALE

SECTION PRECAST CONCRETE BOX CULVERT APRON

SCALE

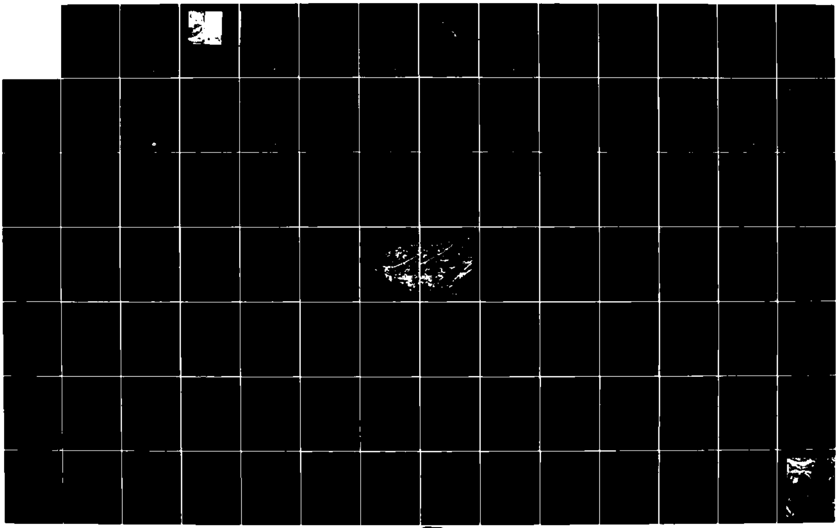
WISCONSIN

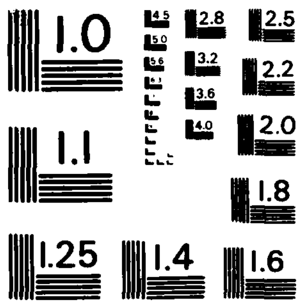
SECTION 6 x 8 BOX CULVERT REINFORCEMENT

AD-A133 795 BASSETT CREEK WATERSHED HENNEPIN COUNTY MINNESOTA FEASIBILITY REPORT FOR FLOOD CONTROL MAIN REPORT(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 82

2/7

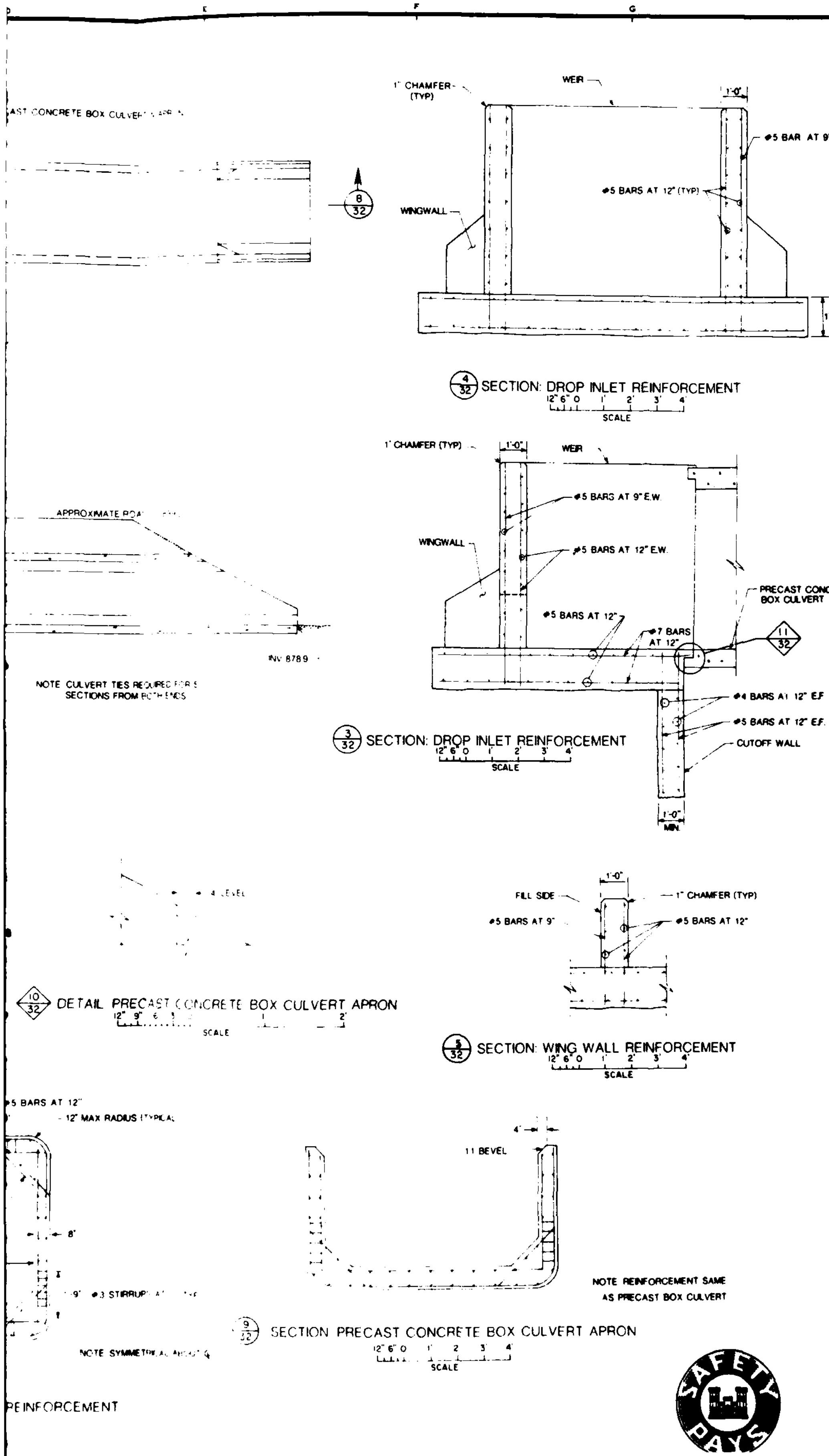
UNCLASSIFIED F/G 13/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

U. S. ARMY



SYMBOL	DESCRIPTION	DATE	APPROVAL

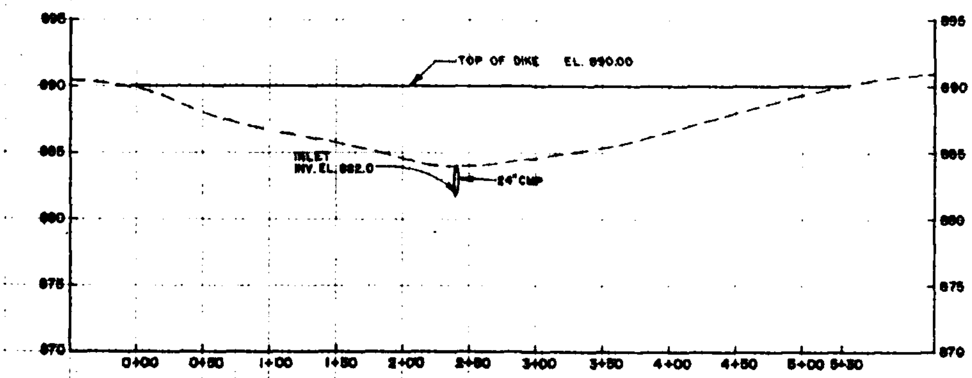
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: BARR ENG. CO	PHASE II — DESIGN MEMORANDUM
DRAWN BY: P.W.	FLOOD CONTROL — BASSETT CREEK MINNESOTA
CHECKED BY: L.A.R.	WISCONSIN AVE EMBANKMENT
SUBMITTED BY:	SECTION AND DETAILS
APPROVED:	DATE: AUGUST 1982
SCALE: AS SHOWN	DRAWING NUMBER: M34.3-R-57/214
	SHEET 32 OF 44

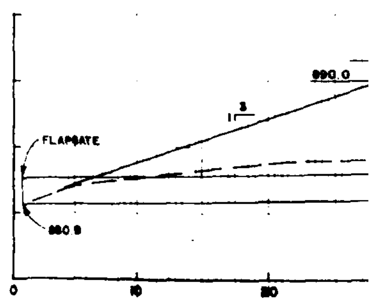
PLATE 32

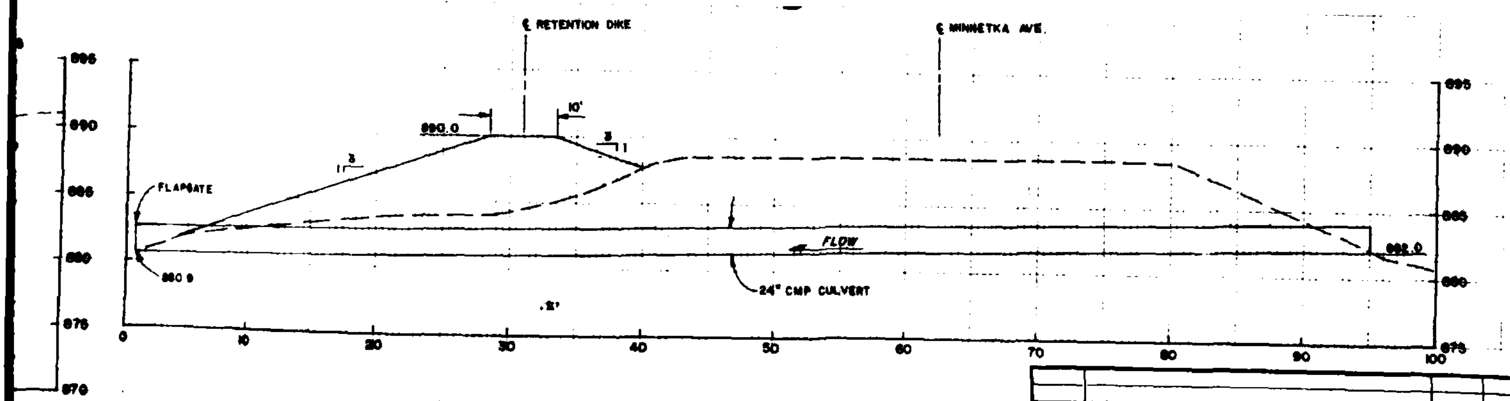
PLAN

50 0 50 100 150
SCALE IN FEET



PROFILE





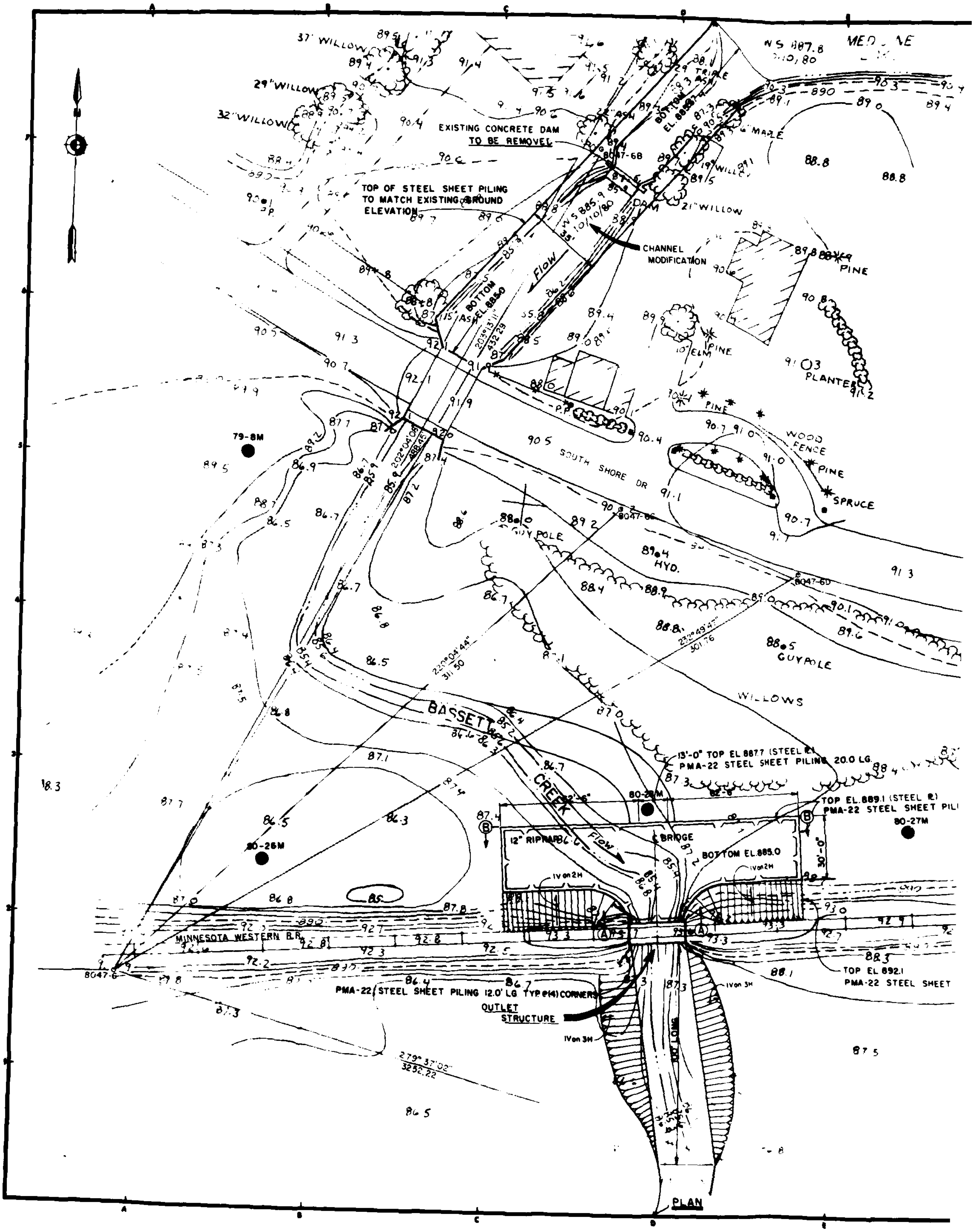
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

D.W.R.	PHASE II DESIGN MEMORANDUM
DRAWN BY: J.M.J.	FLOOD CONTROL BASSETT CREEK MINNESOTA
CHECKED BY: D.W.R.	WINNETKA AVENUE
SUBMITTED BY:	PLAN AND PROFILE
APPROVED:	DATE: AUGUST 1982

SCALE: AS SHOWN

DRAWING NUMBER
M34.3-R-5/216
SHEET 33 OF 44

PLATE 33


37" WILLOW
29" WILLOW
32" WILLOW
EXISTING CONCRETE DAM TO BE REMOVED
TOP OF STEEL SHEET PILING TO MATCH EXISTING GROUND ELEVATION
W.S. 887.8 10/10/80
W.S. 885.9 10/10/80
BOTTOM EL. 885.0
CHANNEL MODIFICATION
FLOW
MAPLE
21" WILLOW
PINE
ELM
PLANTER
WOOD FENCE
SPRUCE
SOUTH SHORE DR
GUY POLE
HYD.
WILLOWS
79-8M
80-26M
80-28M
80-27M
BASSETT CREEK
13'-0" TOP EL 887.7 (STEEL R.) PMA-22 STEEL SHEET PILING 20.0 LG.
TOP EL.889.1 (STEEL R.) PMA-22 STEEL SHEET PILING
12" RIPRAP
BRIDGE
BOTTOM EL.885.0
1V on 2H
MINNESOTA WESTERN R.R.
TOP EL 892.1 PMA-22 STEEL SHEET
PMA-22 STEEL SHEET PILING 12.0' LG TYP (4) CORNERS
OUTLET STRUCTURE
1V on 3H
279° 37' 02" 3232.22
PLAN

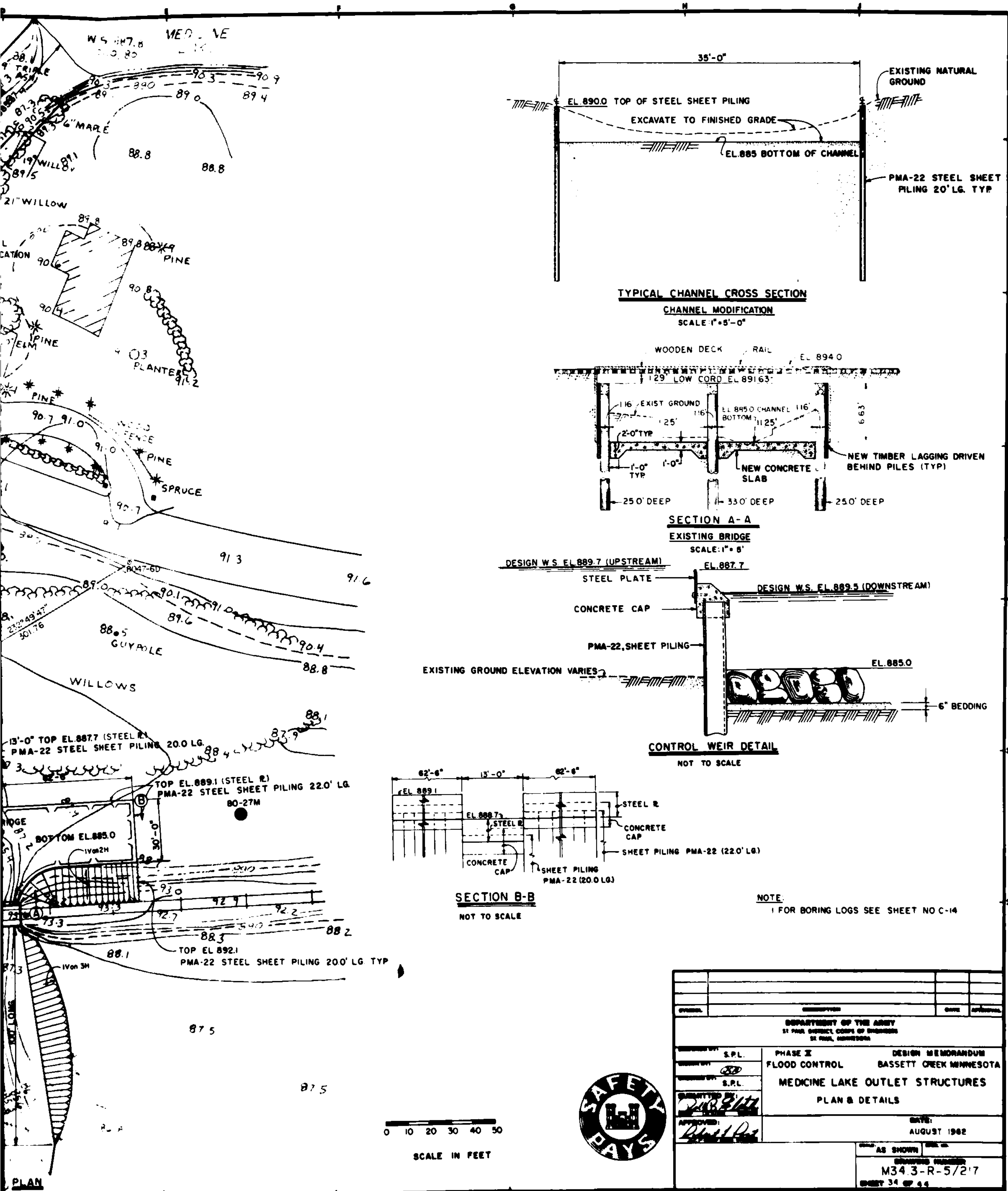
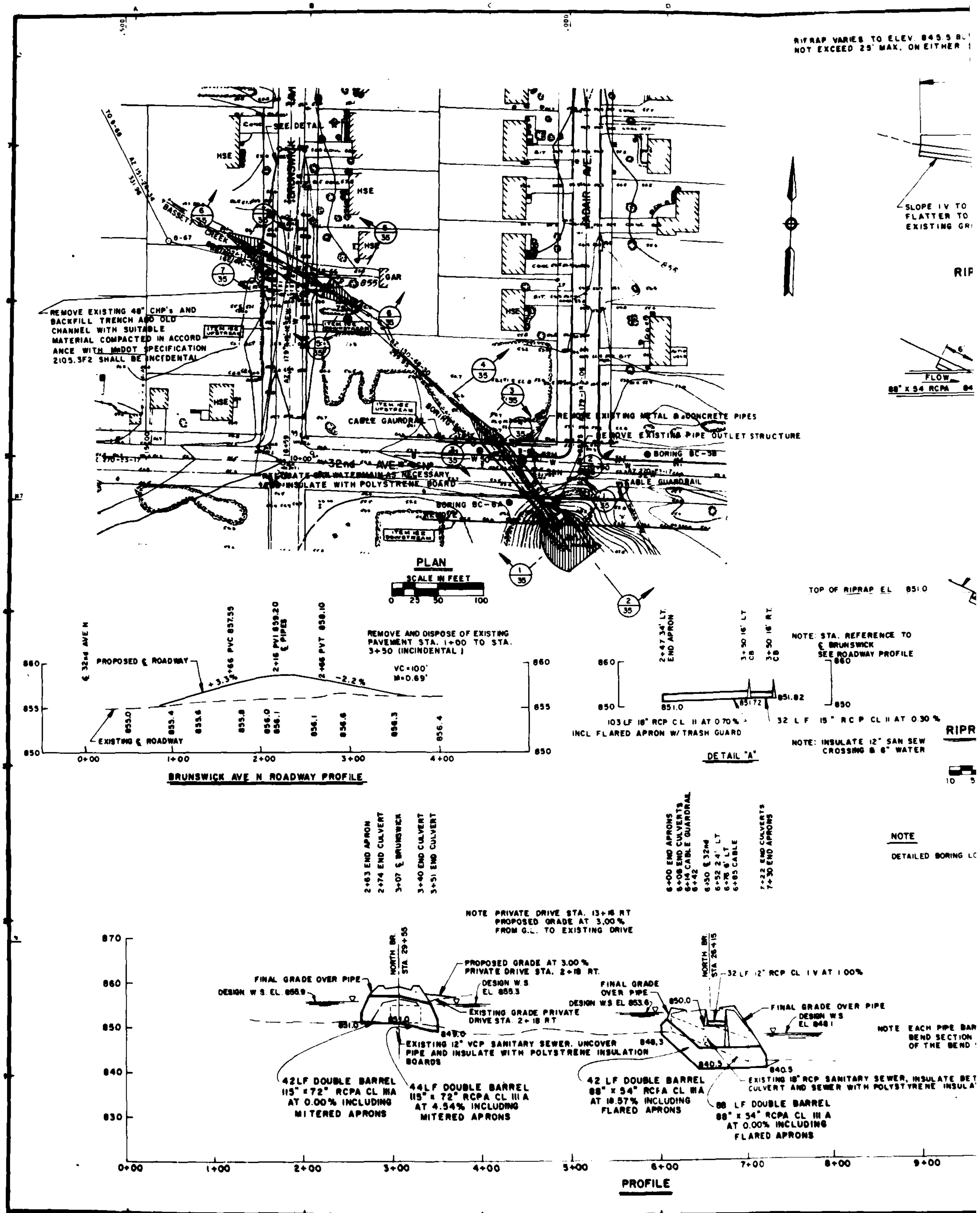
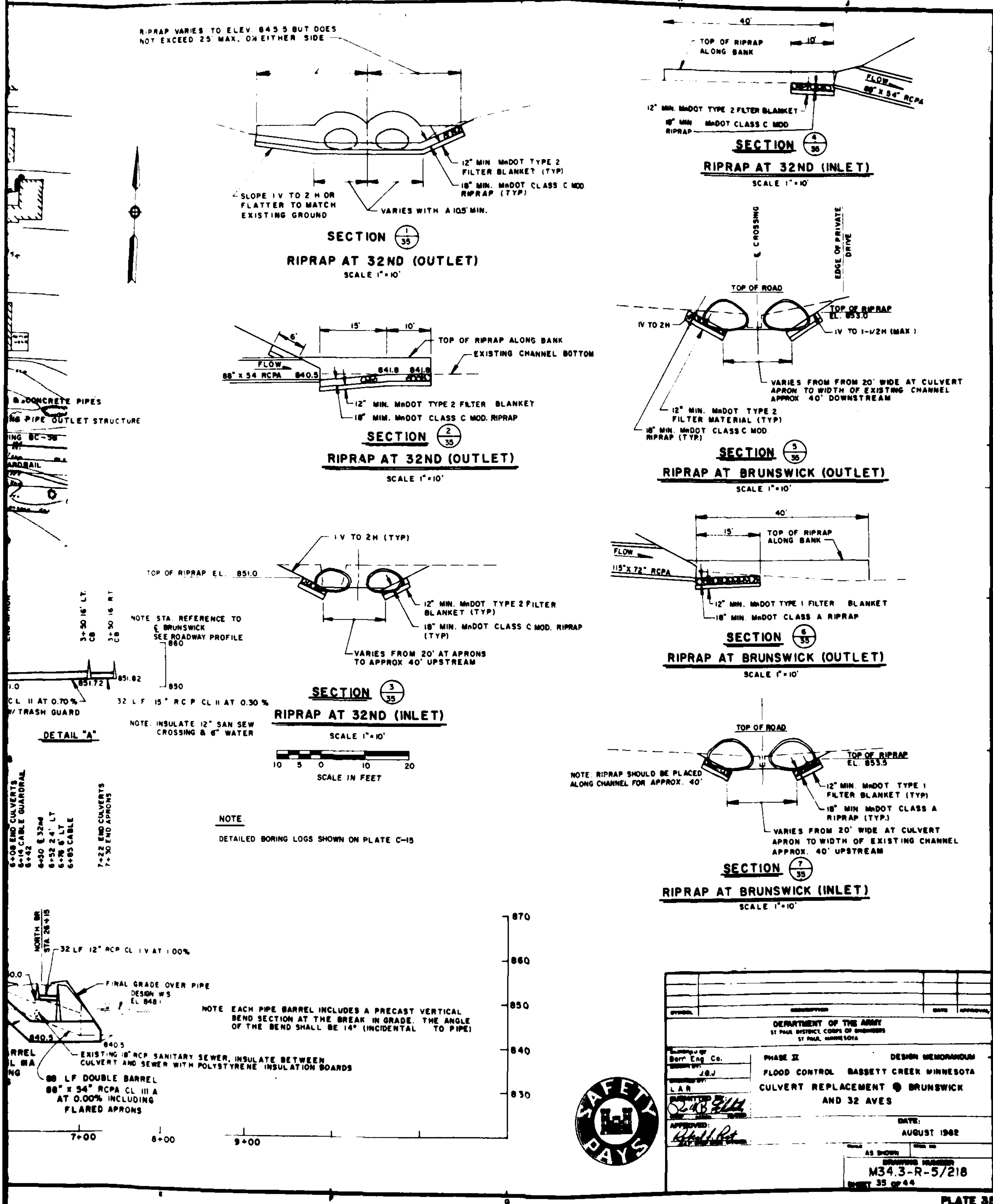
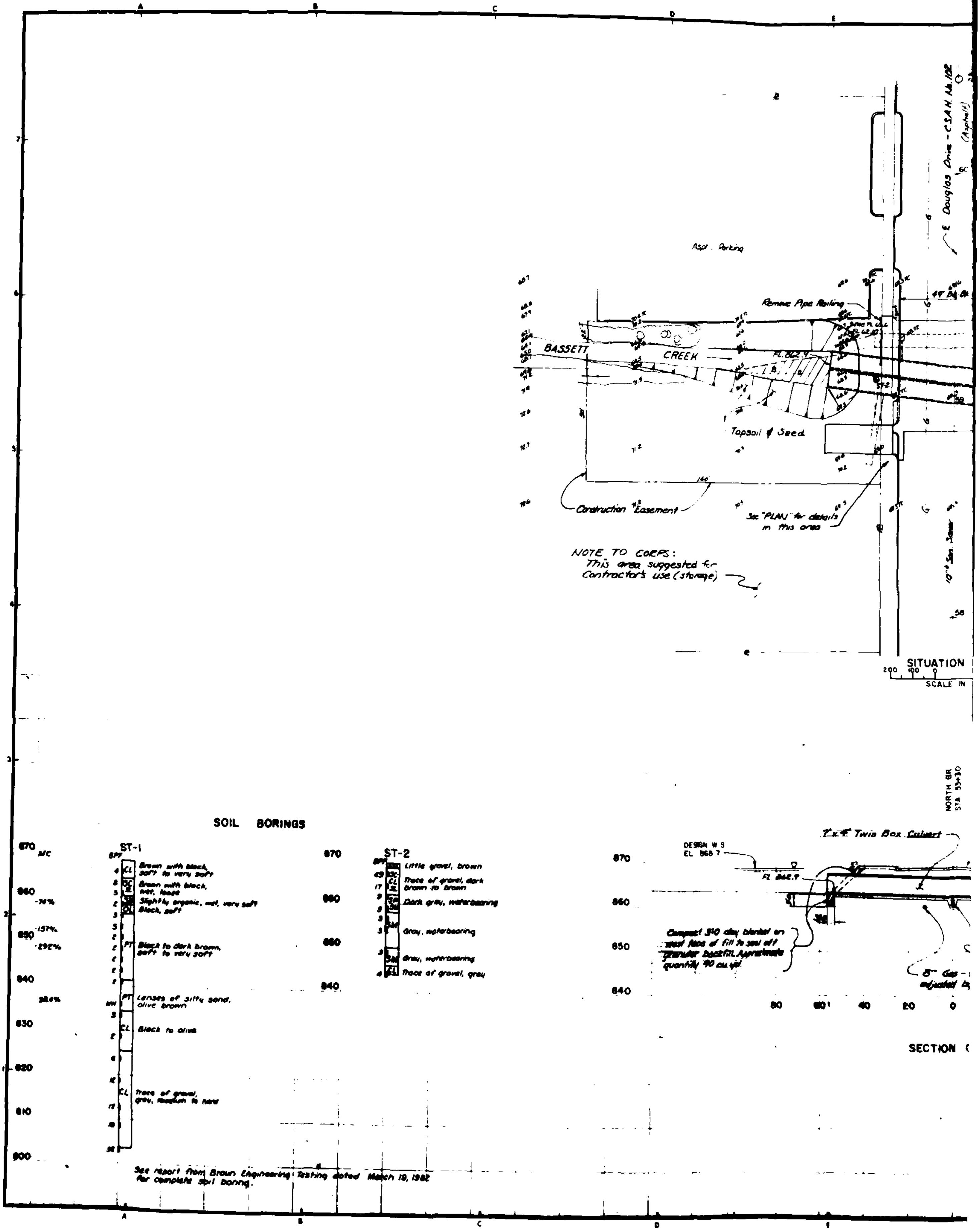

35'-0"
EXISTING NATURAL GROUND
EL. 890.0 TOP OF STEEL SHEET PILING
EXCAVATE TO FINISHED GRADE
EL.885 BOTTOM OF CHANNEL
PMA-22 STEEL SHEET PILING 20' LG. TYP.
TYPICAL CHANNEL CROSS SECTION
CHANNEL MODIFICATION
SCALE 1"=5'-0"
WOODEN DECK
RAIL
EL 894.0
LOW CORD EL 891.63
EXIST GROUND
EL 885.0 CHANNEL BOTTOM
2'-0" TYP
1'-0" TYP
NEW CONCRETE SLAB
NEW TIMBER LAGGING DRIVEN BEHIND PILES (TYP)
25.0' DEEP
33.0' DEEP
25.0' DEEP
SECTION A-A
EXISTING BRIDGE
DESIGN W.S. EL.889.7 (UPSTREAM)
EL. 887.7
STEEL PLATE
DESIGN W.S. EL.889.5 (DOWNSTREAM)
CONCRETE CAP
PMA-22 SHEET PILING
EXISTING GROUND ELEVATION VARIES
EL. 885.0
6" BEDDING
CONTROL WEIR DETAIL
NOT TO SCALE
62'-6"
13'-0"
62'-6"
EL 889.1
EL 888.7
STEEL PL
STEEL PL
CONCRETE CAP
SHEET PILING PMA-22 (22.0' LG.)
CONCRETE CAP
SHEET PILING PMA-22 (20.0 LG.)
SECTION B-B
NOT TO SCALE
NOTE:
1 FOR BORING LOGS SEE SHEET NO C-14
WILLOWS
GUY POLE
PINE
SPRUCE
21" WILLOW
13'-0" TOP EL.887.7 (STEEL PL) PMA-22 STEEL SHEET PILING 20.0 LG.
TOP EL.889.1 (STEEL PL) PMA-22 STEEL SHEET PILING 22.0' LG.
80-27M
BOTTOM EL.885.0
30'-0"
1V on 2H
1V on 3H
TOP EL 892.1 PMA-22 STEEL SHEET PILING 20.0' LG. TYP
PLAN
0 10 20 30 40 50
SCALE IN FEET
SAFETY PAYS
S.P.L.
S.P.L.
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL
BASSETT CREEK MINNESOTA
MEDICINE LAKE OUTLET STRUCTURES
PLAN & DETAILS
AUGUST 1982
AS SHOWN
M34.3-R-5/27
34 44

PLATE 34

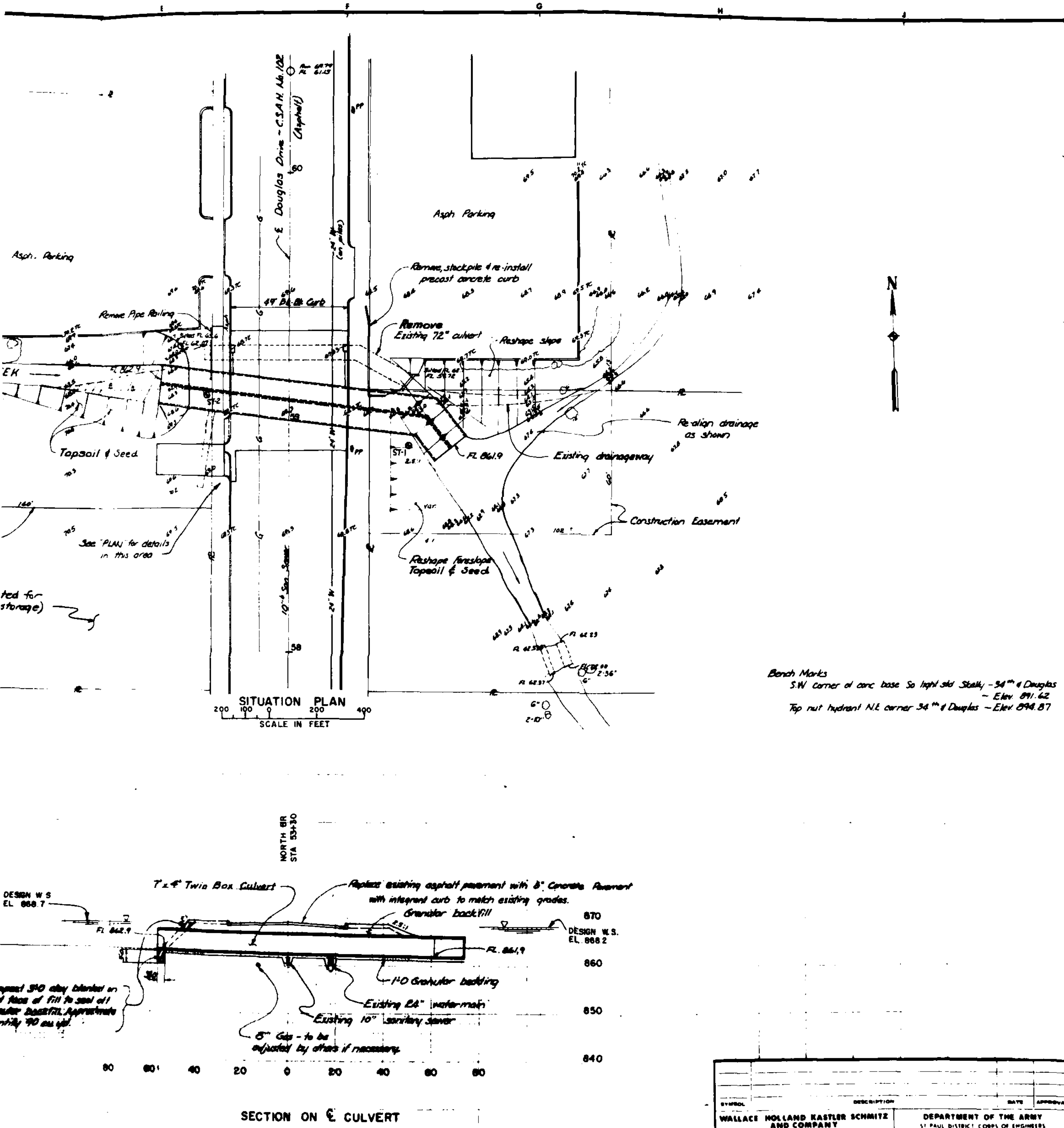


RIPRAP VARIES TO ELEV. 845.5 BUT NOT EXCEED 25' MAX. ON EITHER
REMOVE EXISTING 48" CMP's AND BACKFILL TRENCH AND OLD CHANNEL WITH SUITABLE MATERIAL COMPACTED IN ACCORDANCE WITH MnDOT SPECIFICATION 2105.3F2 SHALL BE INCIDENTAL
REMOVE EXISTING METAL & CONCRETE PIPES
REMOVE EXISTING PIPE OUTLET STRUCTURE
BORING BC-5B
CABLE GUARDRAIL
32nd AVE
RELOCATE WATERMAIN AS NECESSARY AND INSULATE WITH POLYSTRENE BOARD
BORING BC-6A
PLAN
SCALE IN FEET
0 25 50 100
SLOPE 1V TO FLATTER TO EXISTING GR
FLOW
88" X 54 RCPA
TOP OF RIPRAP EL 851.0
REMOVE AND DISPOSE OF EXISTING PAVEMENT STA. 1+00 TO STA. 3+50 (INCINDENTAL)
PROPOSED ℄ ROADWAY
EXISTING ℄ ROADWAY
℄ 32nd AVE N
1+66 PVC 857.55
2+16 PVI 859.20 ℄ PIPES
2+66 PVT 858.10
+3.3%
-2.2%
VC=100'
M=0.69'
BRUNSWICK AVE N ROADWAY PROFILE
2+47.34' LT. END APRON
3+50 16' LT CB
3+50 16' RT CB
NOTE: STA. REFERENCE TO ℄ BRUNSWICK SEE ROADWAY PROFILE
103 LF 18" RCP CL II AT 0.70% INCL FLARED APRON W/ TRASH GUARD
32 L F 15" R C P CL II AT 0.30%
NOTE: INSULATE 12" SAN SEW CROSSING & 6" WATER
DETAIL "A"
NOTE
DETAILED BORING LO
2+63 END APRON
2+74 END CULVERT
3+07 ℄ BRUNSWICK
3+40 END CULVERT
3+51 END CULVERT
6+00 END APRONS
6+08 END CULVERTS
6+14 CABLE GUARDRAIL
6+42
6+50 ℄ 32nd
6+52 24" LT
6+76 6" LT
6+83 CABLE
7+22 END CULVERTS
7+30 END APRONS
NOTE PRIVATE DRIVE STA. 13+16 RT PROPOSED GRADE AT 3.00% FROM G.L. TO EXISTING DRIVE
NORTH BR STA 29+55
NORTH BR STA 26+15
PROPOSED GRADE AT 3.00% PRIVATE DRIVE STA. 2+18 RT.
FINAL GRADE OVER PIPE
DESIGN W.S. EL. 855.9
DESIGN W.S. EL 855.3
EXISTING GRADE PRIVATE DRIVE STA. 2+18 RT
EXISTING 12" VCP SANITARY SEWER. UNCOVER PIPE AND INSULATE WITH POLYSTRENE INSULATION BOARDS
42LF DOUBLE BARREL 115" x 72" RCPA CL IIIA AT 0.00% INCLUDING MITERED APRONS
44LF DOUBLE BARREL 115" x 72" RCPA CL III A AT 4.54% INCLUDING MITERED APRONS
FINAL GRADE OVER PIPE
DESIGN W.S. EL 853.6
32 LF 12" RCP CL IV AT 1.00%
FINAL GRADE OVER PIPE
DESIGN W.S EL 848.1
42 LF DOUBLE BARREL 88" x 54" RCPA CL IIIA AT 18.57% INCLUDING FLARED APRONS
88 LF DOUBLE BARREL 88" x 54" RCPA CL III A AT 0.00% INCLUDING FLARED APRONS
EXISTING 18" RCP SANITARY SEWER, INSULATE BETWEEN CULVERT AND SEWER WITH POLYSTYRENE INSULATION
NOTE EACH PIPE BAR BEND SECTION OF THE BEND
PROFILE


RIPRAP VARIES TO ELEV. 845.5 BUT DOES NOT EXCEED 25' MAX. ON EITHER SIDE
12" MIN. MnDOT TYPE 2 FILTER BLANKET (TYP)
18" MIN. MnDOT CLASS C MOD RIPRAP (TYP)
SLOPE 1V TO 2H OR FLATTER TO MATCH EXISTING GROUND
VARIES WITH A 10.5' MIN.
SECTION 1/35
RIPRAP AT 32ND (OUTLET)
SCALE 1"=10'
6'
15'
10'
TOP OF RIPRAP ALONG BANK
EXISTING CHANNEL BOTTOM
FLOW
88" x 54 RCPA
840.5
841.8
841.8
12" MIN. MnDOT TYPE 2 FILTER BLANKET
18" MIN. MnDOT CLASS C MOD. RIPRAP
SECTION 2/35
RIPRAP AT 32ND (OUTLET)
SCALE 1"=10'
1V TO 2H (TYP)
TOP OF RIPRAP EL. 851.0
12" MIN. MnDOT TYPE 2 FILTER BLANKET (TYP)
18" MIN. MnDOT CLASS C MOD. RIPRAP (TYP)
VARIES FROM 20' AT APRONS TO APPROX 40' UPSTREAM
SECTION 3/35
RIPRAP AT 32ND (INLET)
SCALE 1"=10'
10 5 0 10 20
SCALE IN FEET
NOTE:
DETAILED BORING LOGS SHOWN ON PLATE C-15
40'
10'
TOP OF RIPRAP ALONG BANK
FLOW
88" X 54" RCPA
12" MIN. MnDOT TYPE 2 FILTER BLANKET
18" MIN. MnDOT CLASS C MOD RIPRAP
SECTION 4/35
RIPRAP AT 32ND (INLET)
SCALE 1"=10'
℄ CROSSING
EDGE OF PRIVATE DRIVE
TOP OF ROAD
TOP OF RIPRAP EL. 853.0
1V TO 2H
1V TO 1-1/2H (MAX)
VARIES FROM FROM 20' WIDE AT CULVERT APRON TO WIDTH OF EXISTING CHANNEL APPROX 40' DOWNSTREAM
12" MIN. MnDOT TYPE 2 FILTER MATERIAL (TYP)
18" MIN. MnDOT CLASS C MOD RIPRAP (TYP)
SECTION 5/35
RIPRAP AT BRUNSWICK (OUTLET)
SCALE 1"=10'
40'
15'
TOP OF RIPRAP ALONG BANK
FLOW
115" X 72" RCPA
12" MIN. MnDOT TYPE 1 FILTER BLANKET
18" MIN. MnDOT CLASS A RIPRAP
SECTION 6/35
RIPRAP AT BRUNSWICK (OUTLET)
SCALE 1"=10'
TOP OF ROAD
TOP OF RIPRAP EL. 853.5
NOTE: RIPRAP SHOULD BE PLACED ALONG CHANNEL FOR APPROX. 40'
12" MIN. MnDOT TYPE 1 FILTER BLANKET (TYP)
18" MIN MnDOT CLASS A RIPRAP (TYP.)
VARIES FROM 20' WIDE AT CULVERT APRON TO WIDTH OF EXISTING CHANNEL APPROX. 40' UPSTREAM
SECTION 7/35
RIPRAP AT BRUNSWICK (INLET)
SCALE 1"=10'
CONCRETE PIPES
PIPE OUTLET STRUCTURE
3+50 16' LT. CB
3+50 16' RT CB
NOTE STA. REFERENCE TO ℄ BRUNSWICK SEE ROADWAY PROFILE
860
850
851.72
851.82
CL II AT 0.70%
W/ TRASH GUARD
32 LF 15" RCP CL II AT 0.30%
NOTE: INSULATE 12" SAN SEW CROSSING & 6" WATER
DETAIL "A"
6+08 END CULVERTS
6+16 CABLE GUARDRAIL
6+42
6+50 ℄ 32nd
6+52 24' LT
6+76 6' LT
6+85 CABLE
7+22 END CULVERTS
7+30 END APRONS
NORTH BR STA. 26+15
32 LF 12" RCP CL IV AT 1.00%
FINAL GRADE OVER PIPE
DESIGN WS EL 848
840.5
840.5
EXISTING 18" RCP SANITARY SEWER, INSULATE BETWEEN CULVERT AND SEWER WITH POLYSTYRENE INSULATION BOARDS
88 LF DOUBLE BARREL 88" x 54" RCPA CL III A AT 0.00% INCLUDING FLARED APRONS
NOTE: EACH PIPE BARREL INCLUDES A PRECAST VERTICAL BEND SECTION AT THE BREAK IN GRADE. THE ANGLE OF THE BEND SHALL BE 14° (INCIDENTAL TO PIPE)
870
860
850
840
830
7+00
8+00
9+00
SAFETY PAYS
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
Barr Eng. Co.
J.B.J
L.A.R.
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
CULVERT REPLACEMENT @ BRUNSWICK AND 32 AVES
DATE: AUGUST 1982
AS SHOWN
M34.3-R-5/218
SHEET 35 OF 44
PLATE 35



E Douglas Drive - C.S.A.H. No. 102
(Asphalt)
Asp. Parking
Remove Pipe Railing
BASSETT
CREEK
FL 862.9
Topsoil & Seed
Construction Easement
See "PLAN" for details in this area
NOTE TO CORPS:
This area suggested for Contractor's use (storage)
10" San. Sewer
SITUATION
SCALE IN
NORTH BR
STA 53+30
SOIL BORINGS
ST-1
Brown with black, soft to very soft
Brown with black, wet, loose
Slightly organic, wet, very soft
Black, soft
Black to dark brown, soft to very soft
Lenses of silty sand, olive brown
Black to olive
Trace of gravel, grey, medium to hard
ST-2
Little gravel, brown
Trace of gravel, dark brown to brown
Dark grey, waterbearing
Gray, waterbearing
Gray, waterbearing
Trace of gravel, grey
See report from Braun Engineering Testing dated March 19, 1982 for complete soil boring.
DESIGN W.S. EL 868.7
FL 862.9
Twin Box Culvert
Compact 3/10 clay blanket on west face of fill to seal off granular backfill. Approximate quantity 90 cu. yd.
SECTION



SYMBOL	DESCRIPTION	DATE	APPROVAL

WALLACE HOLLAND KASTLER SCHMITZ AND COMPANY
ROCHESTER MINNESOTA

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

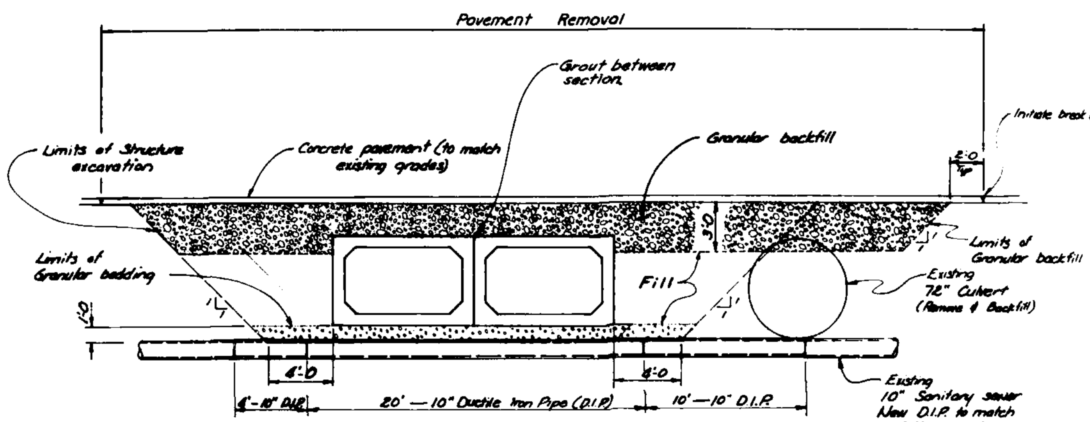
DESIGNED BY G.W.H.
DRAWN BY D.C.L. J.M.J.
CHECKED BY L.A.R.
SUBMITTED BY
APPROVED

DESIGN MEMORANDUM
PHASE II
FLOOD CONTROL BASSETT CREEK MINNESOTA
CULVERT REPLACEMENTS AT DOUGLAS DRIVE
PLAN, SOIL BORINGS AND SECTION

DATE AUGUST 1982
SCALE AS SHOWN
DRAWING NUMBER M34.3-R-5/219
SHEET 36 OF 41

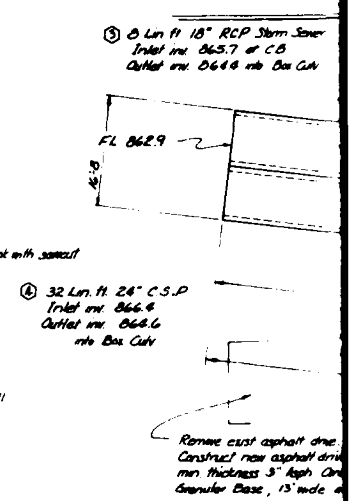
SAFETY PAYS

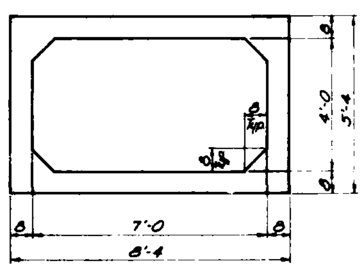
PLATE 36



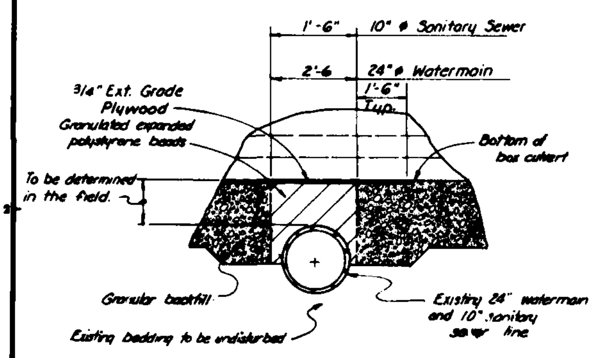
SECTION ALONG ℄ OF ROADWAY
SCALE 1/4" = 1'-0"

0 2 4 6 8 10
SCALE IN FEET





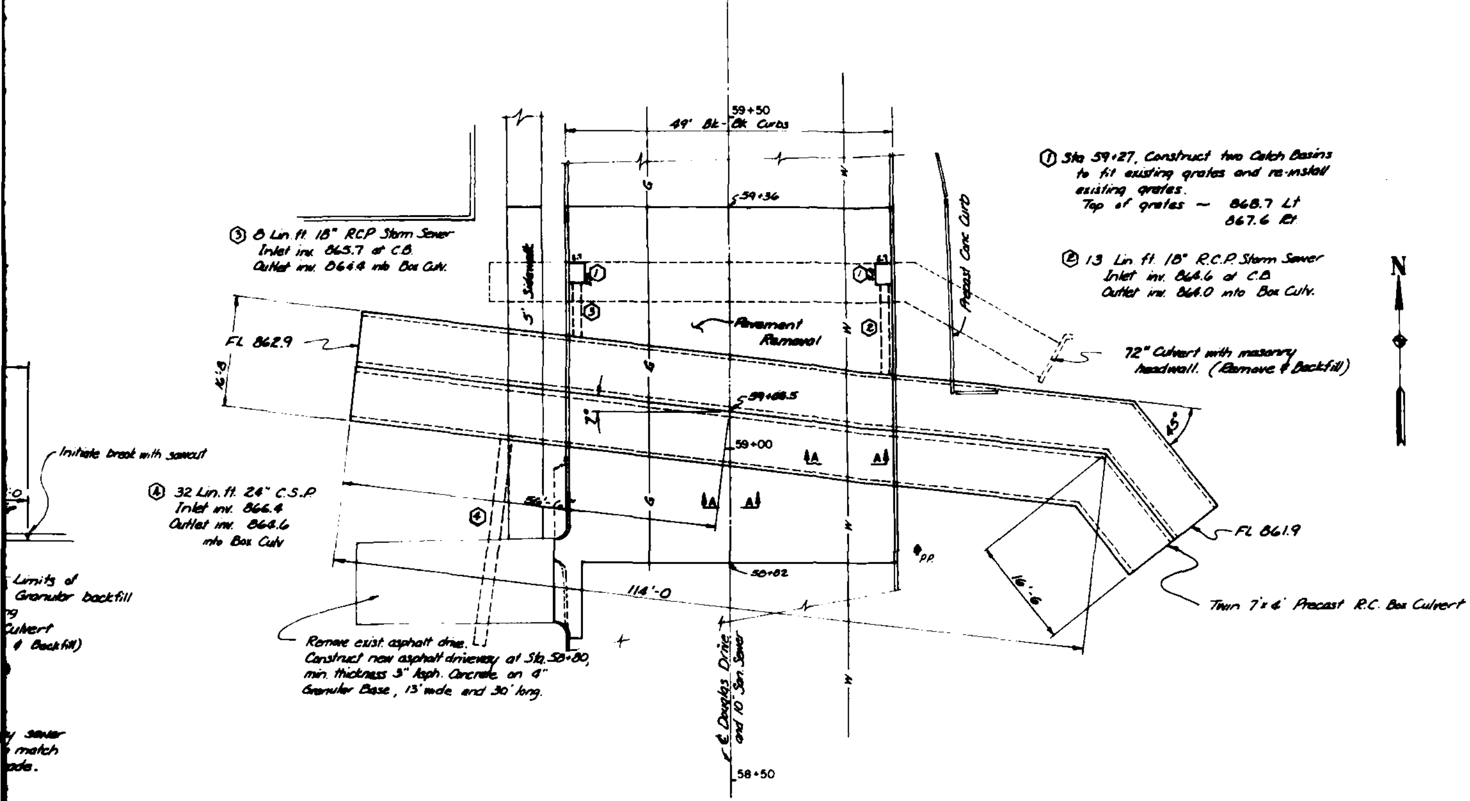
TYPICAL PRECAST REINFORCED CONCRETE BOX CULVERT SECTION
SCALE 1/2" = 1'-0"



SECTIO...
SCALE 1/2 = 1'-0"

Section shown sh... ...tend full width of culvert and a minimum of 3'-0" beyond each side.

0 1 2 3 4 5
SCALE IN FEET

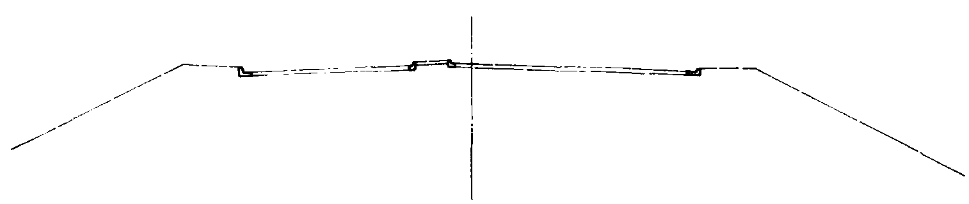


PLAN

SCALE 1" = 10'

10 5 0 10 20 30

SCALE IN FEET



FUTURE ROADWAY SECTION

SCALE 1" = 10' HOR
1" = 5' VERT

10 5 0 10 20 30

HORIZONTAL SCALE IN FEET

5 0 5 10 15

VERTICAL SCALE IN FEET

SYMBOL	DESCRIPTION	DATE	APPROVAL

WALLACE HOLLAND KASTLER SCHMITZ AND COMPANY
ROCHESTER MINNESOTA

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

CULVERT REPLACEMENTS AT DOUGLAS DRIVE

DETAILS

DESIGNED BY: G.H.H.
DRAWN BY: R.C.L. / M.J.
CHECKED BY: L.A.R.
SUBMITTED BY:
APPROVED:

DATE: AUGUST 1982

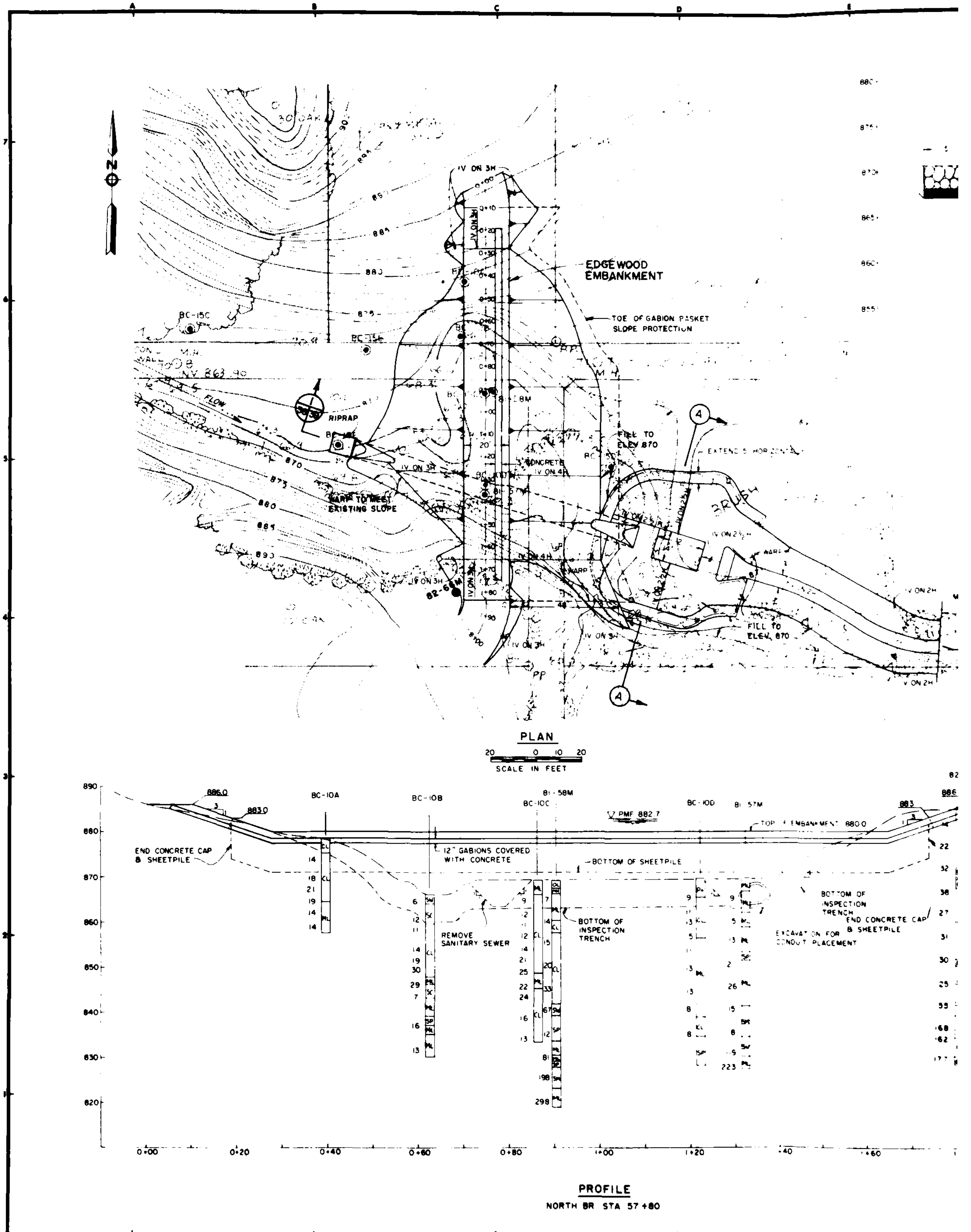
SCALE: AS SHOWN

DRAWING NUMBER: M34.3-R-5/220

SHEET 37 OF 44

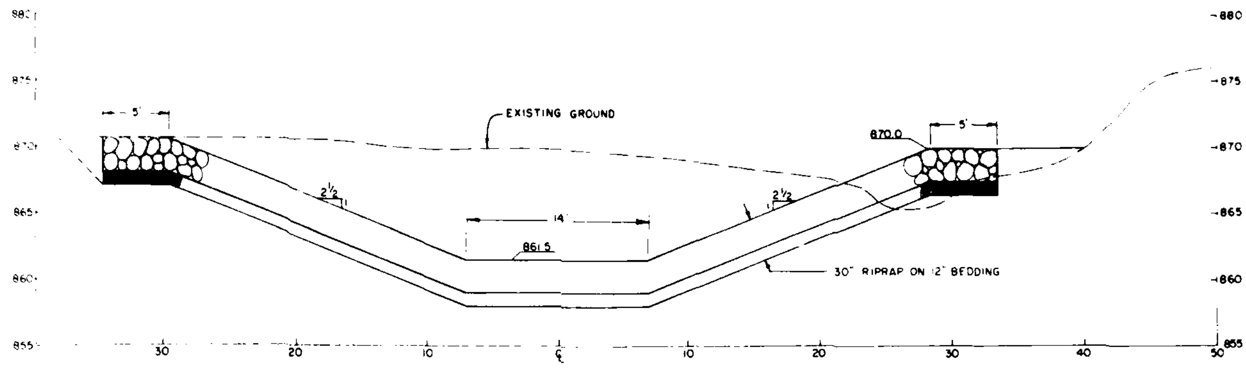
SAFETY PAYS

PLATE 37

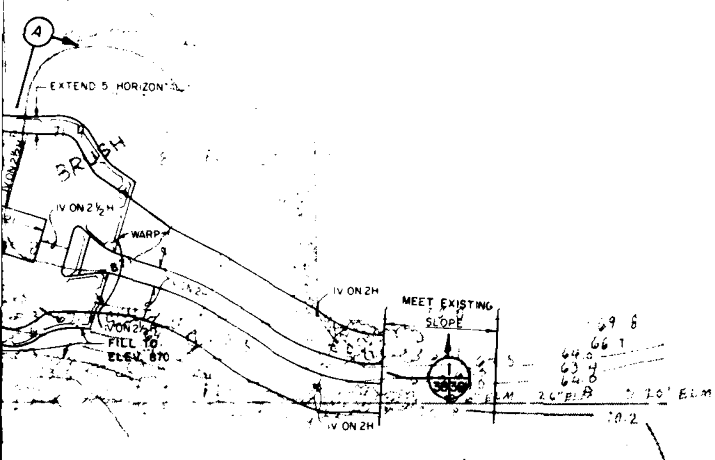


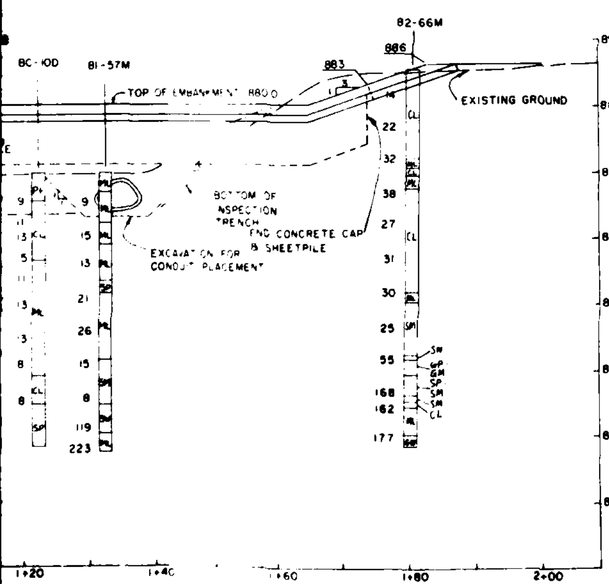
PROFILE

NORTH BR STA 57+80



SECTION A





NOTE:
SEE SHEET C-16 FOR DETAIL BORING LOGS.

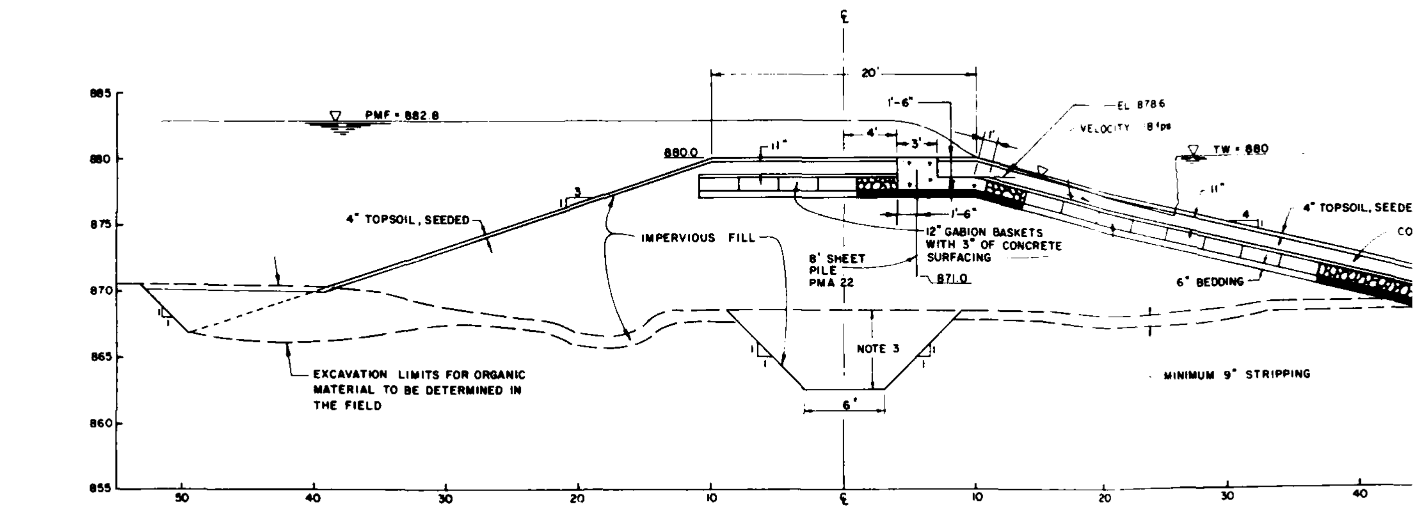
SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

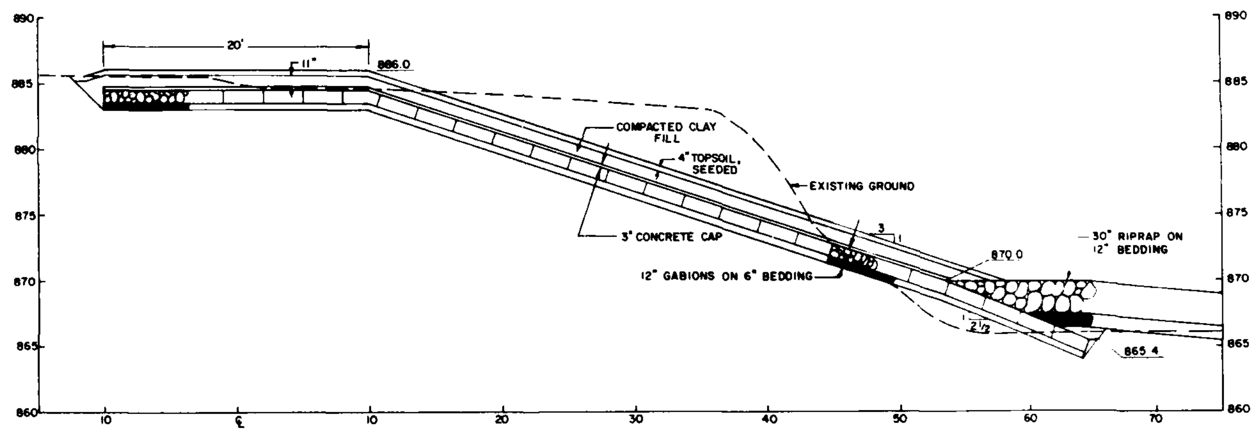
DESIGNED BY: DR, PMF
DRAWN BY: JGJ
CHECKED BY: MB
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
EDGEWOOD EMBANKMENT
GENERAL PLAN & PROFILE
DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-5/22
SHEET 38 OF 44

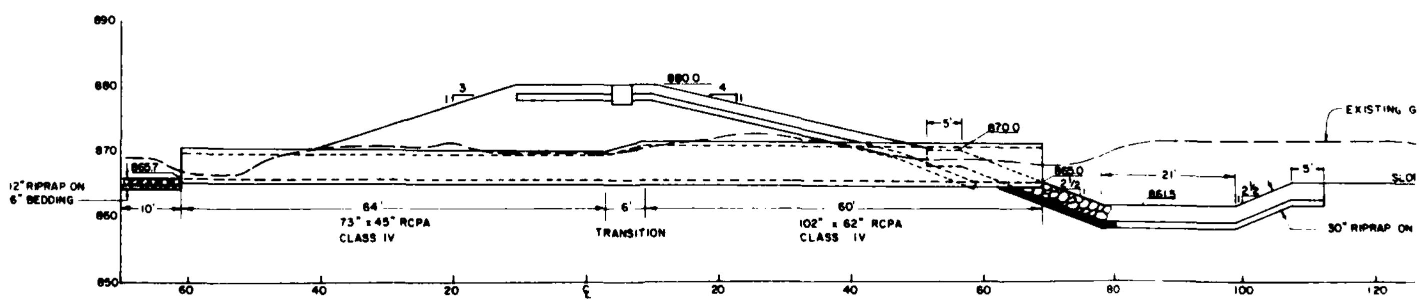
PLATE 38



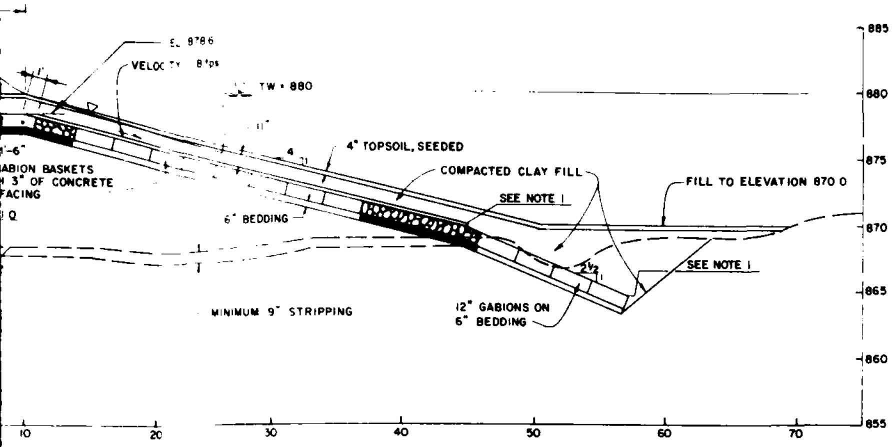
TYPICAL SECTION (Sta 0+28 to Sta 1+66)



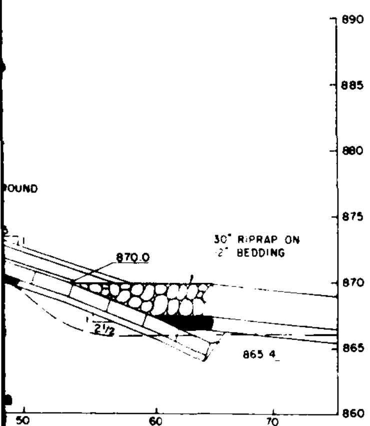
STATION 1+83

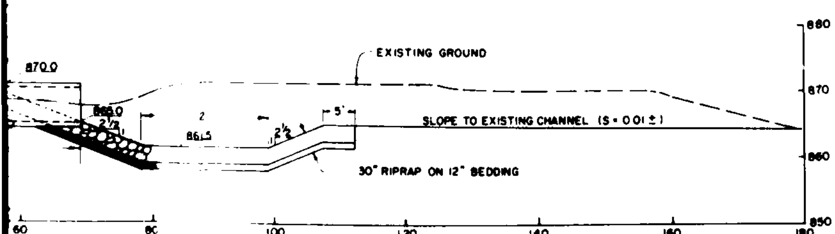


CONDUIT PROFILE



0+28 to Sta 1+66)





NOTES:

1. FROM STA 0+10 TO STA 0+80, THE GABIONS SLOPE AT 1V ON 4H TO THE EXISTING GROUND SURFACE, THEN 1V ON 2 1/2 H TO A DEPTH OF 5' BELOW THE GROUND SURFACE. FROM STA 0+80 TO STA 1+66 THE GABIONS SLOPE AT 1V ON 4H TO ELEVATION 870, THEN AT 1V ON 2 1/2 H TO ELEVATION 864.4. AT STA 1+83 THE GABIONS SLOPE AT 1V ON 3H TO ELEVATION 870, THEN AT 1V ON 2 1/2 H TO ELEVATION 865.4. BETWEEN STA 1+66 AND STA 1+83 THE SLOPE IS WARPED.
2. AN EROSION-RESISTANT CLAY HAVING A LIQUID LIMIT GREATER THAN 30 AND A PLASTICITY INDEX GREATER THAN 15 WILL BE PLACED IN THE ZONE ABOVE THE GABION BASKETS.
3. WHEN THE EMBANKMENT IS GREATER THAN SIX FEET IN HEIGHT, THE DEPTH OF THE INSPECTION TRENCH IS SIX FEET. WHEN THE EMBANKMENT IS LESS THAN SIX FEET IN HEIGHT, THE DEPTH OF THE INSPECTION TRENCH EQUALS THE HEIGHT OF THE EMBANKMENT.
4. PIPE BEDDING SHALL BE FIRST CLASS BEDDING.

SAFETY PAYS

SYMBOL	DESCRIPTION	DATE	APPROVAL

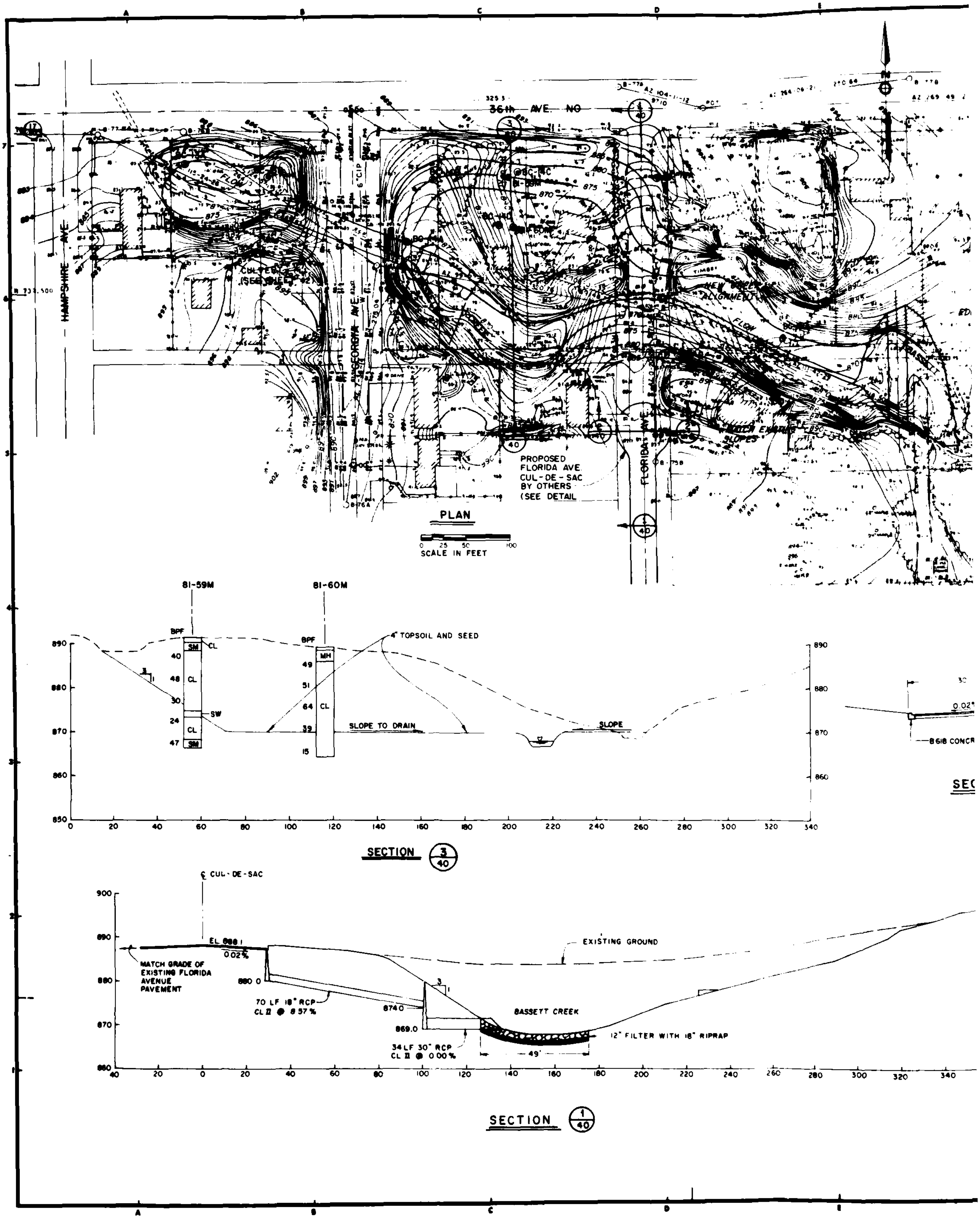
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

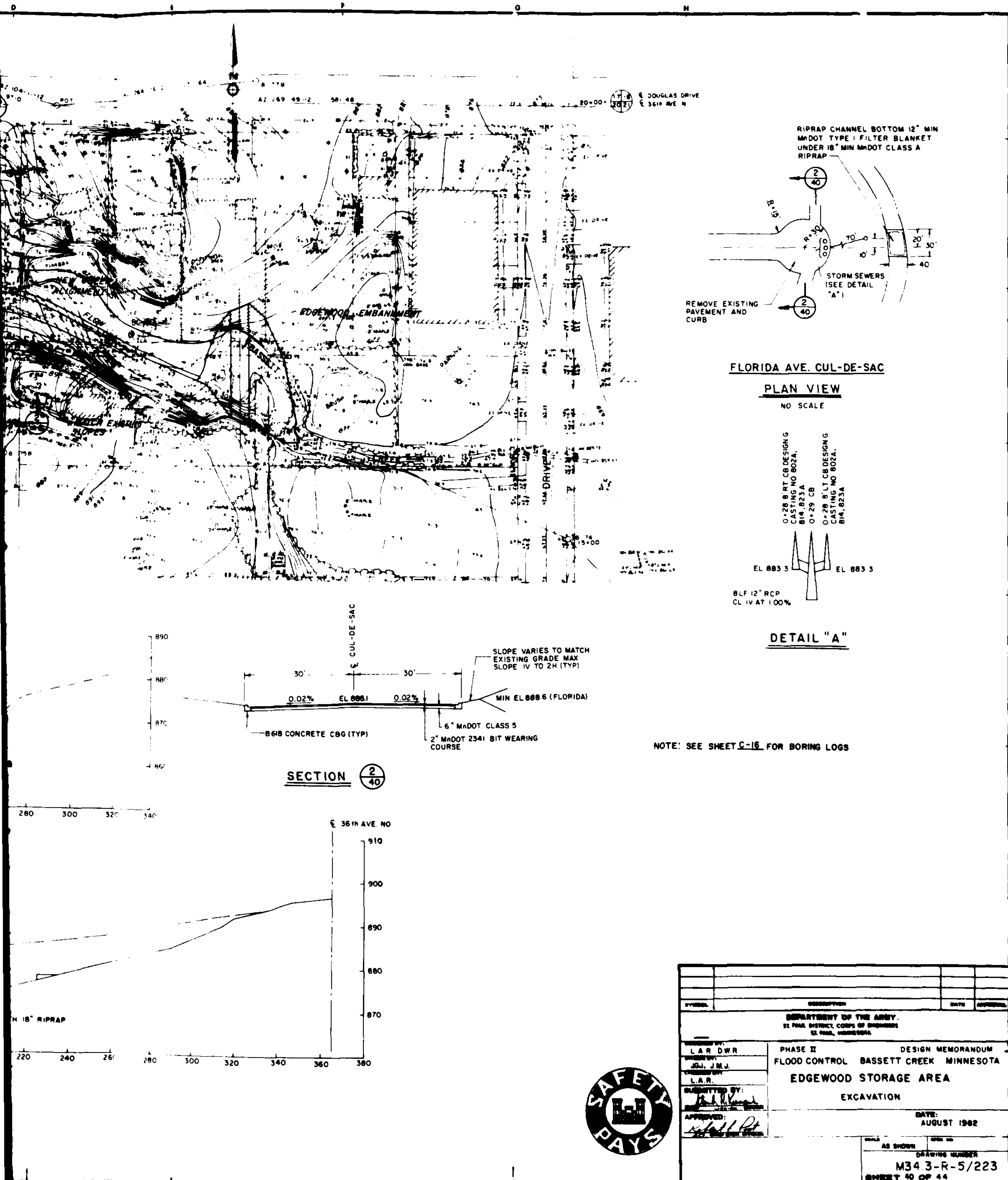
DESIGNED BY: DR, PMF
DRAWN BY: JGJ
CHECKED BY: M.B
SUBMITTED BY:
APPROVED:

PHASE II — DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
EDGEWOOD EMBANKMENT
EMBANKMENT DETAILS

DATE: AUGUST 1982
SCALE: AS SHOWN
SPEC. NO.:
DRAWING NUMBER: M34.3-R-5/222
SHEET 39 OF 44

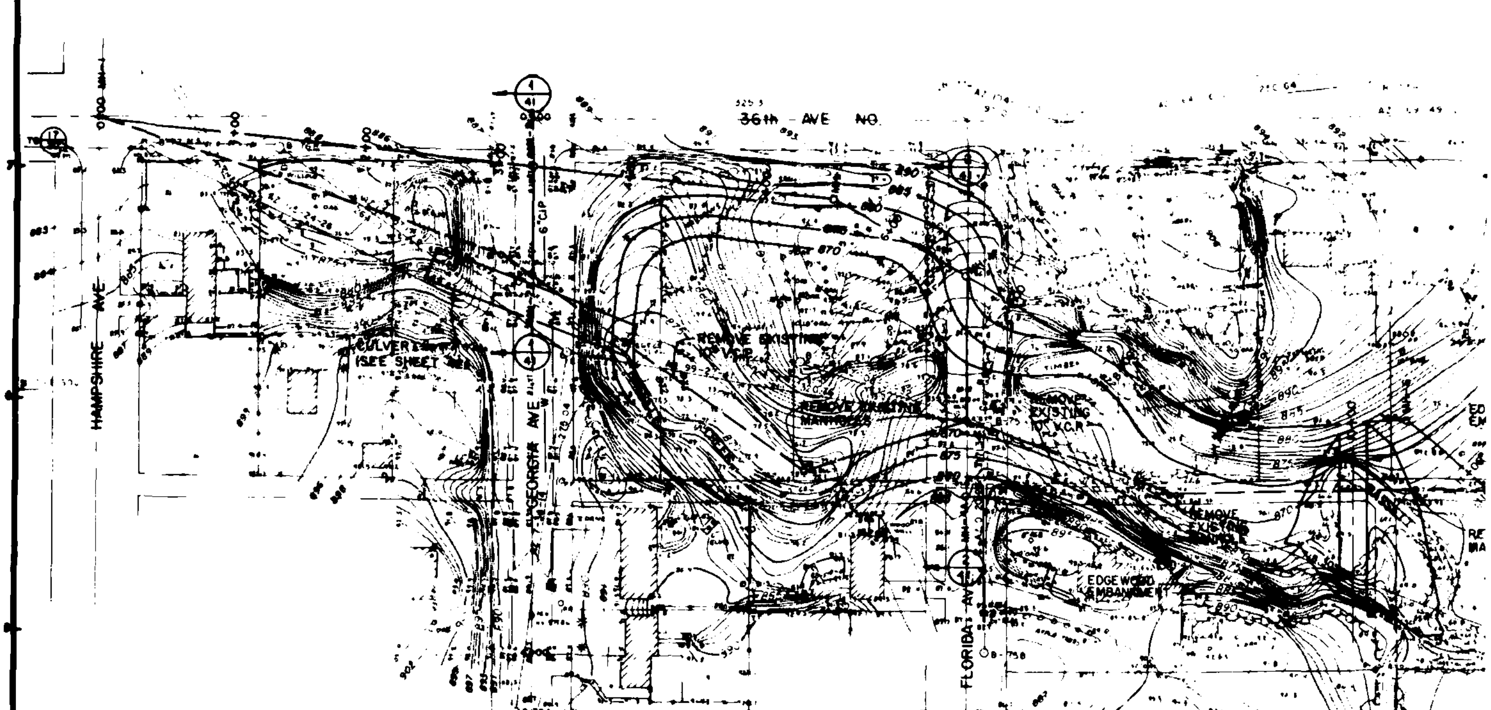
PLATE 39

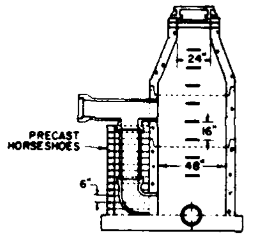

36th AVE. NO
HAMPSHIRE AVE.
GEORGIA AVE.
FLORIDA AVE.
CULVERT (SEE SHEET 42)
NEW CHANNEL ALIGNMENT
FLOW
MATCH EXISTING SLOPES
PROPOSED FLORIDA AVE. CUL-DE-SAC BY OTHERS (SEE DETAIL
PLAN
SCALE IN FEET
81-59M
81-60M
BPF
4" TOPSOIL AND SEED
SLOPE TO DRAIN
SLOPE
SECTION 3/40
℄ CUL-DE-SAC
EL 888±
0.02%
MATCH GRADE OF EXISTING FLORIDA AVENUE PAVEMENT
EXISTING GROUND
880.0
70 LF 18" RCP CL II @ 8.57%
874.0
869.0
34 LF 30" RCP CL II @ 0.00%
BASSETT CREEK
12" FILTER WITH 18" RIPRAP
49'
SECTION 1/40



℄ DOUGLAS DRIVE
℄ 36th AVE N
EDGEWOOD EMBANKMENT
NEW ... ALIGNMENT
FLOW
... EXISTING SLOPES
DRIVE
15+00
RIPRAP CHANNEL BOTTOM 12" MIN MnDOT TYPE I FILTER BLANKET UNDER 18" MIN MnDOT CLASS A RIPRAP
R=15'
R=30'
70'
10'
20'
30'
40
STORM SEWERS (SEE DETAIL "A")
REMOVE EXISTING PAVEMENT AND CURB
FLORIDA AVE. CUL-DE-SAC
PLAN VIEW
NO SCALE
0+28.8 RT CB DESIGN G CASTING NO 802A, 814.823A
0+29 CB
0+28.8 LT CB DESIGN G CASTING NO 802A, 814.823A
EL 883.3
EL 883.3
8LF 12" RCP CL IV AT 1.00%
DETAIL "A"
℄ CUL-DE-SAC
30'
30'
0.02%
EL 888.1
0.02%
SLOPE VARIES TO MATCH EXISTING GRADE MAX SLOPE 1V TO 2H (TYP)
MIN EL 888.6 (FLORIDA)
6" MnDOT CLASS 5
2" MnDOT 2341 BIT WEARING COURSE
B618 CONCRETE C&G (TYP)
SECTION 2/40
NOTE: SEE SHEET C-16 FOR BORING LOGS
℄ 36th AVE. NO
18" RIPRAP
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
L.A.R. D.W.R.
J.G.J., J.M.J.
L.A.R.
SUBMITTED BY:
APPROVED:
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
EDGEWOOD STORAGE AREA
EXCAVATION
DATE: AUGUST 1982
AS SHOWN
M34.3-R-5/223
SHEET 40 OF 44
SAFETY PAYS

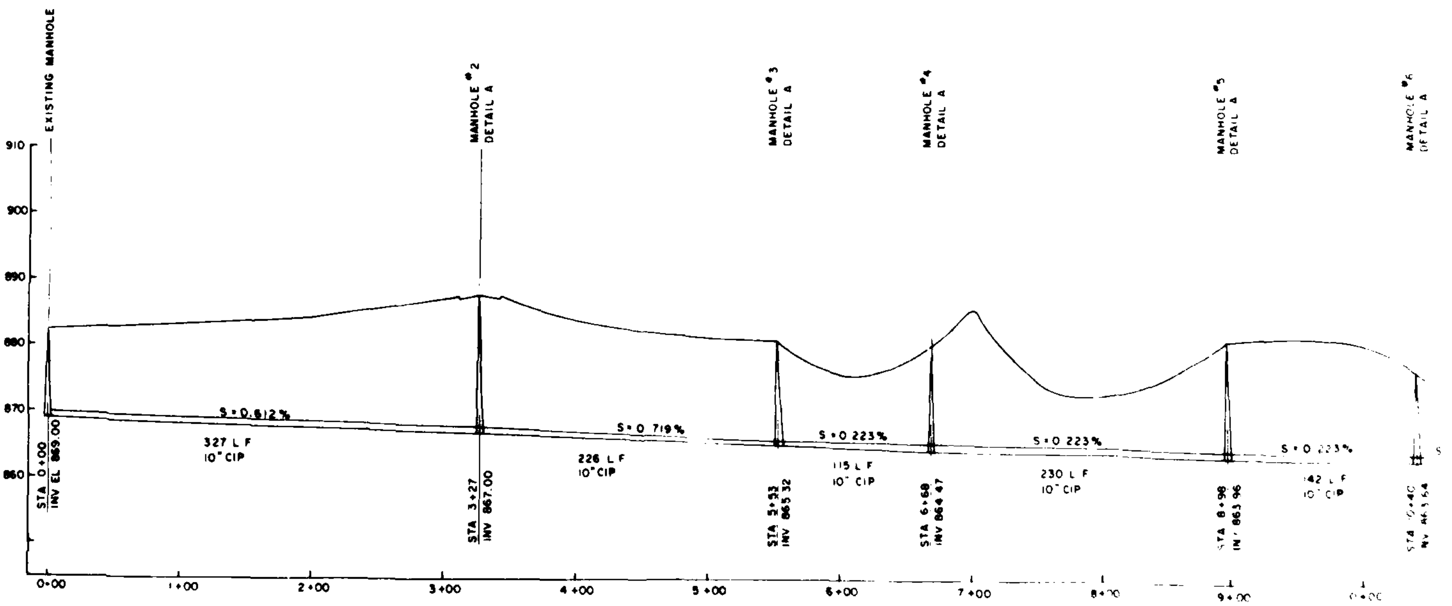
PLATE 40



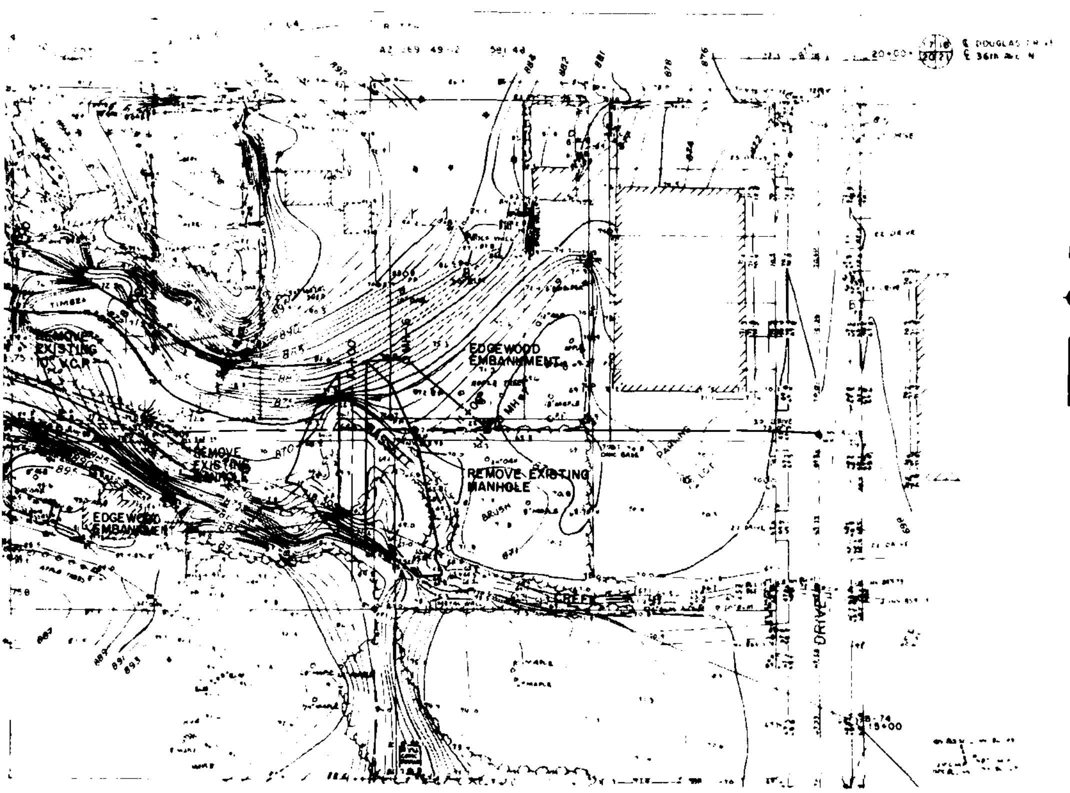


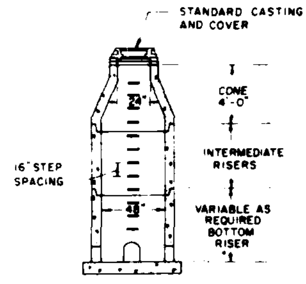
DROP INLET MANHOLE

DETAIL B



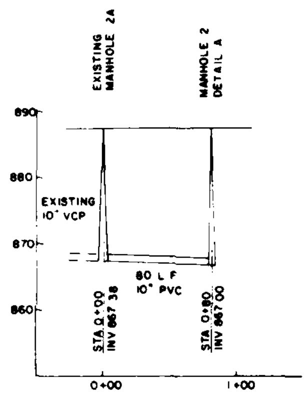
SEWER PROFILE



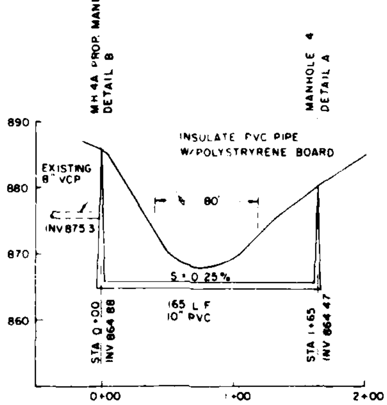


CONCENTRIC MANHOLE

DETAIL A



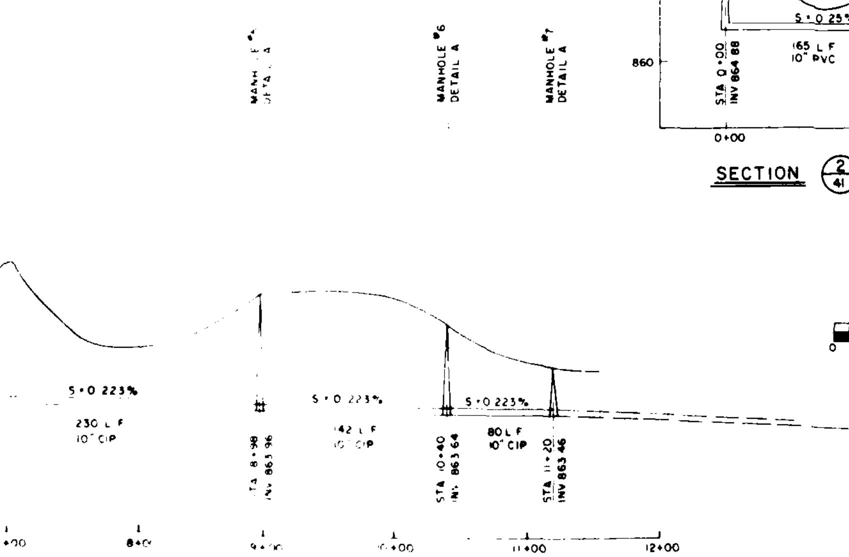
SECTION 1/41



SECTION 2/41

NOTES

1. ALL SANITARY SEWER MANHOLES SHALL BE CONSTRUCTED OF PRECAST CONCRETE SECTIONS
2. ALL JOINTS SHALL BE MADE WATER TIGHT BY USE OF BITUMASTIC JOINT COMPOUND
3. ALL INVERTS OF EXISTING SANITARY LINES SHALL BE VERIFIED PRIOR TO CONSTRUCTION



SCALE IN FEET

0 25 50 100

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY L.A.R.
DRAWN BY JGJ
CHECKED BY L.A.R.
SUBMITTED BY
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

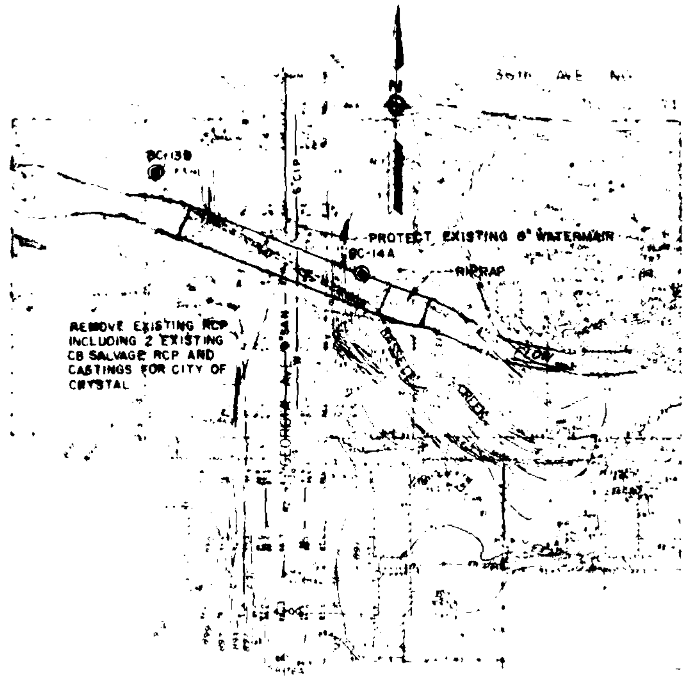
EDGEWOOD STORAGE AREA
UTILITIES

DATE: AUGUST 1982

SCALE AS SHOWN

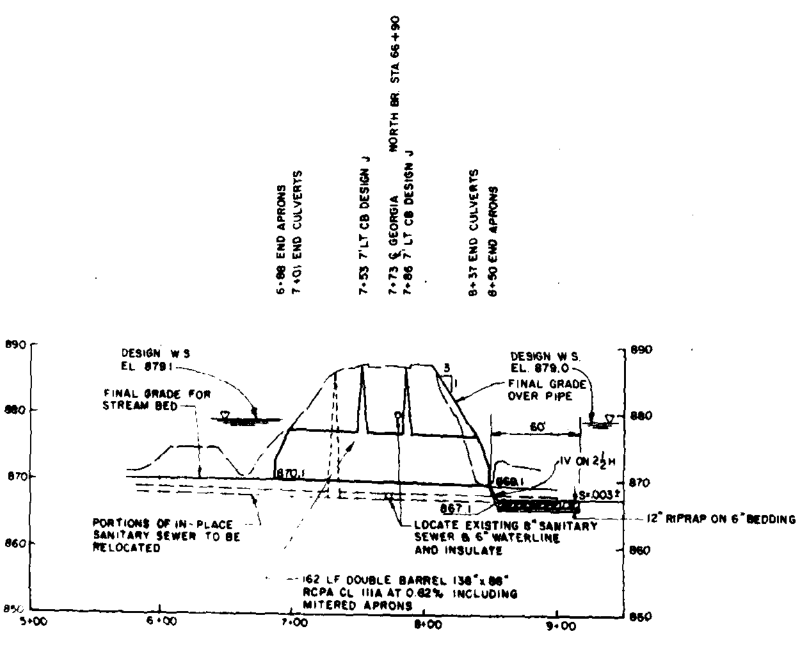
DRAWING NUMBER M34.3-R-5/224

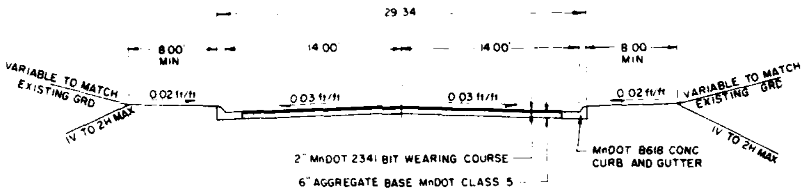
SHEET 41 OF 44



40 20 0 50 100
SCALE IN FEET
1"=50'-0"

NOTE
SEE SHEET C-15
FOR DETAILED BORING LOGS





GEORGIA AVE.
ROADWAY SECTION
NO SCALE

15
BORING LOGS

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

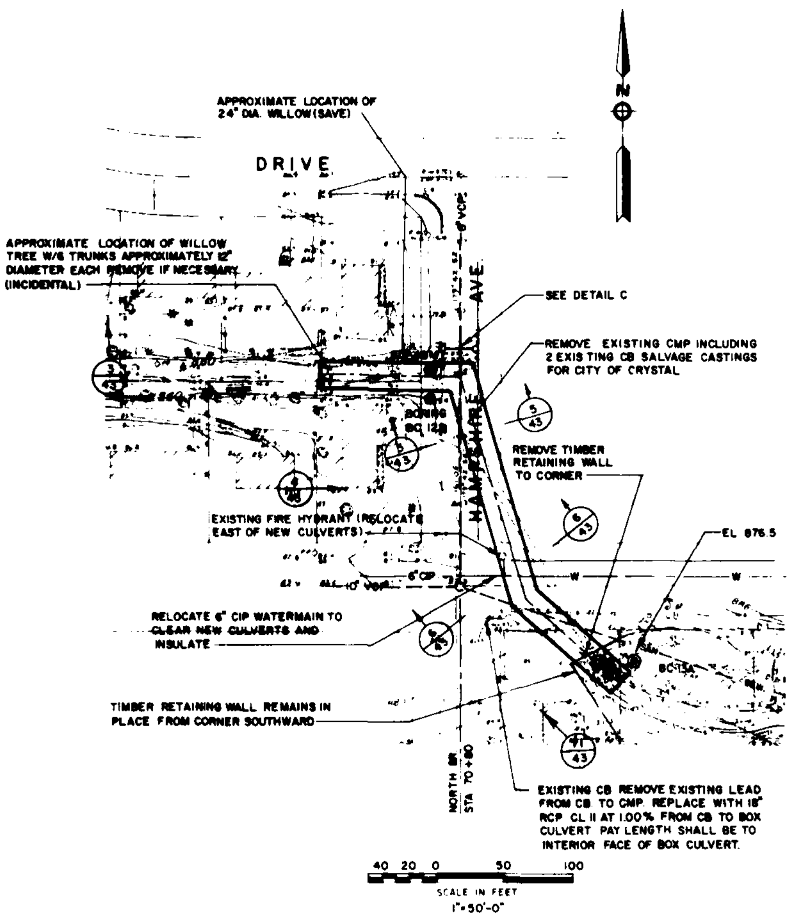
BARR ENG CO
JGJ
LAR
SUBMITTED BY:
APPROVED:

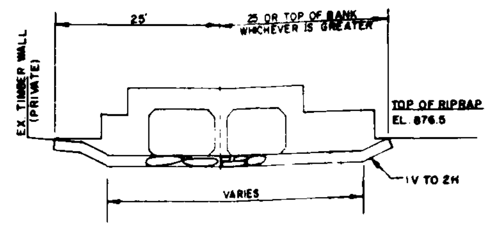
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

CULVERT REPLACEMENT
AT GEORGIA AVE

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34 3-R-5/226
SHEET 42 OF 44

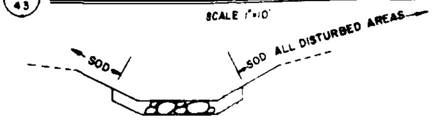
PLATE 42





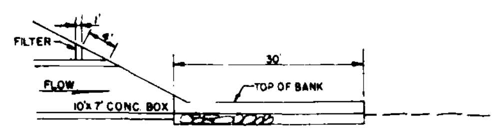
11/43 **SECTION: RIPRAP AT 36TH- HAMPSHIRE (OUTLET)**

SCALE 1"=10'



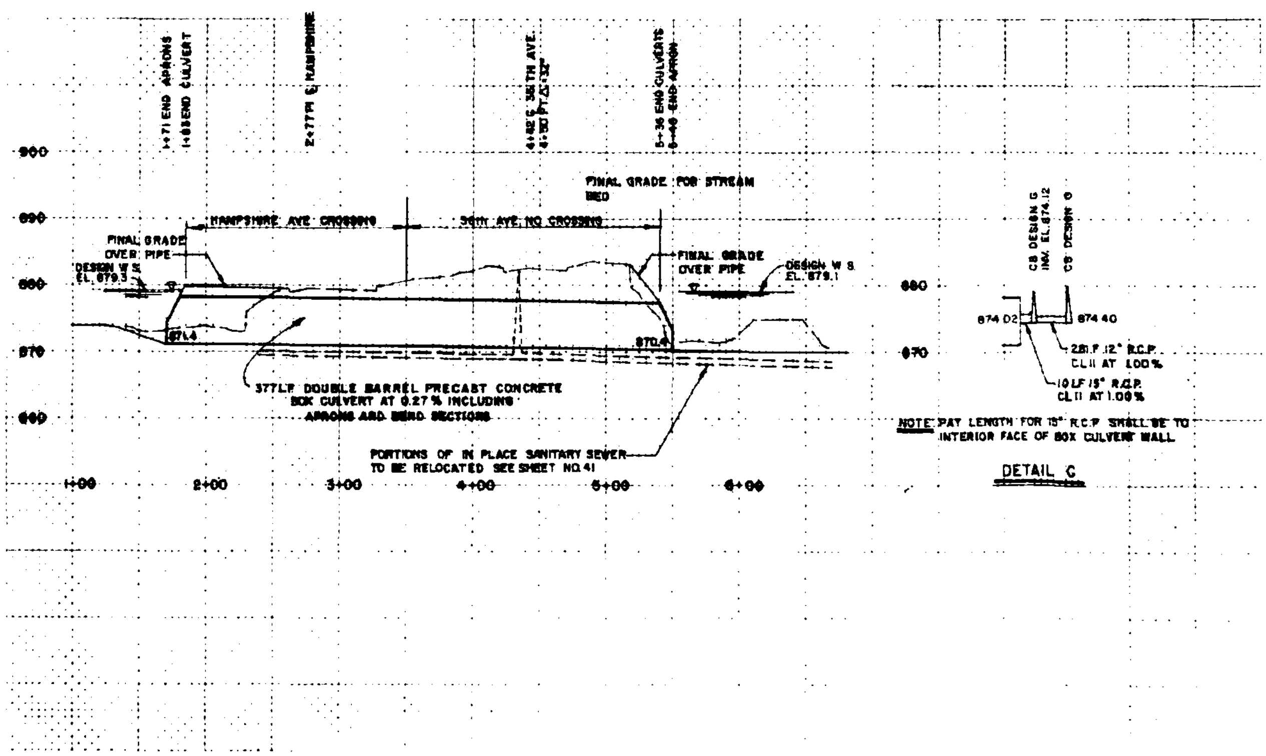
4/43 **TYPICAL SECTION: STATION 1+05 TO STATION 1+70**

SCALE 1"=10'

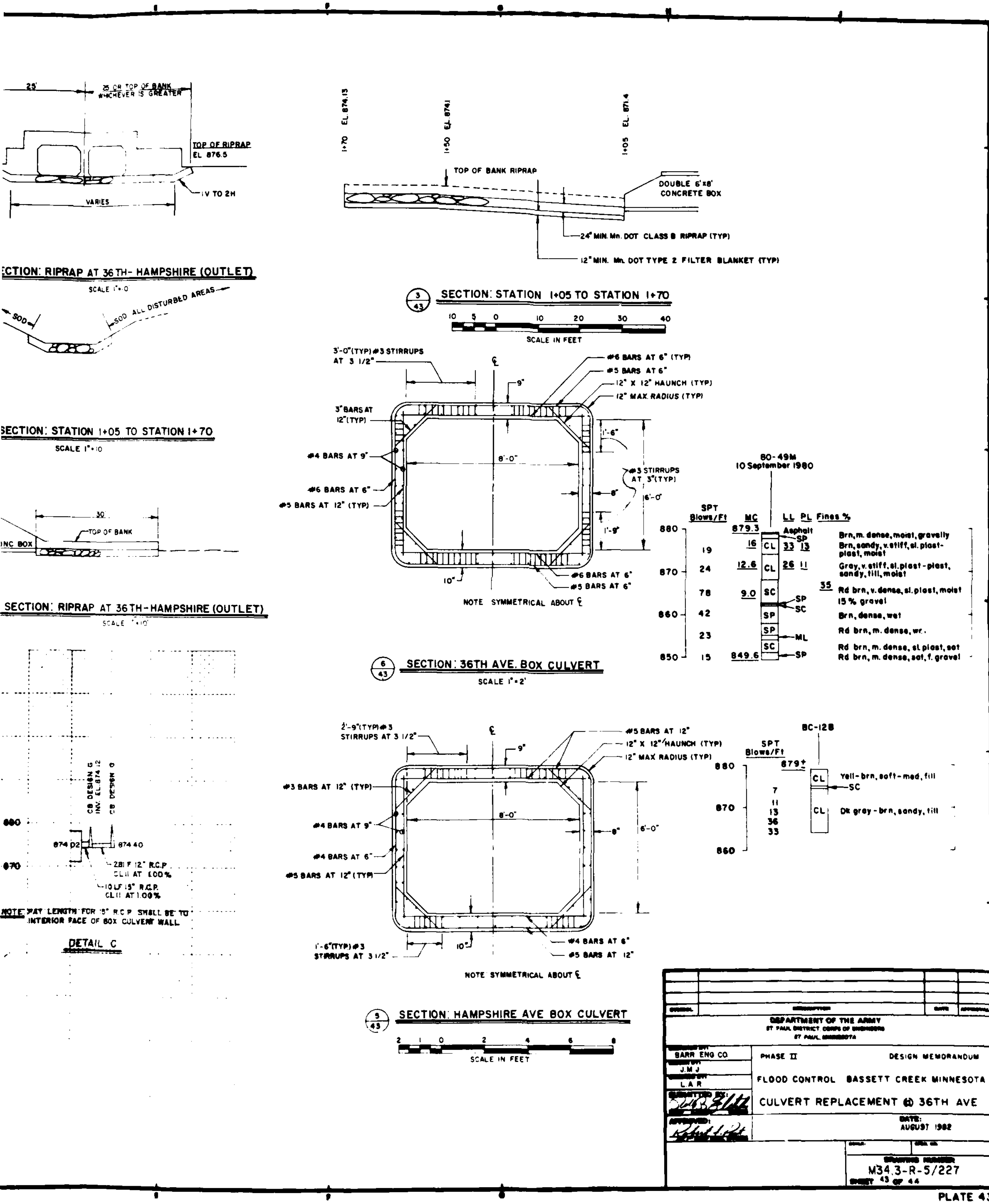


12/43 **SECTION: RIPRAP AT 36TH-HAMPSHIRE (OUTLET)**

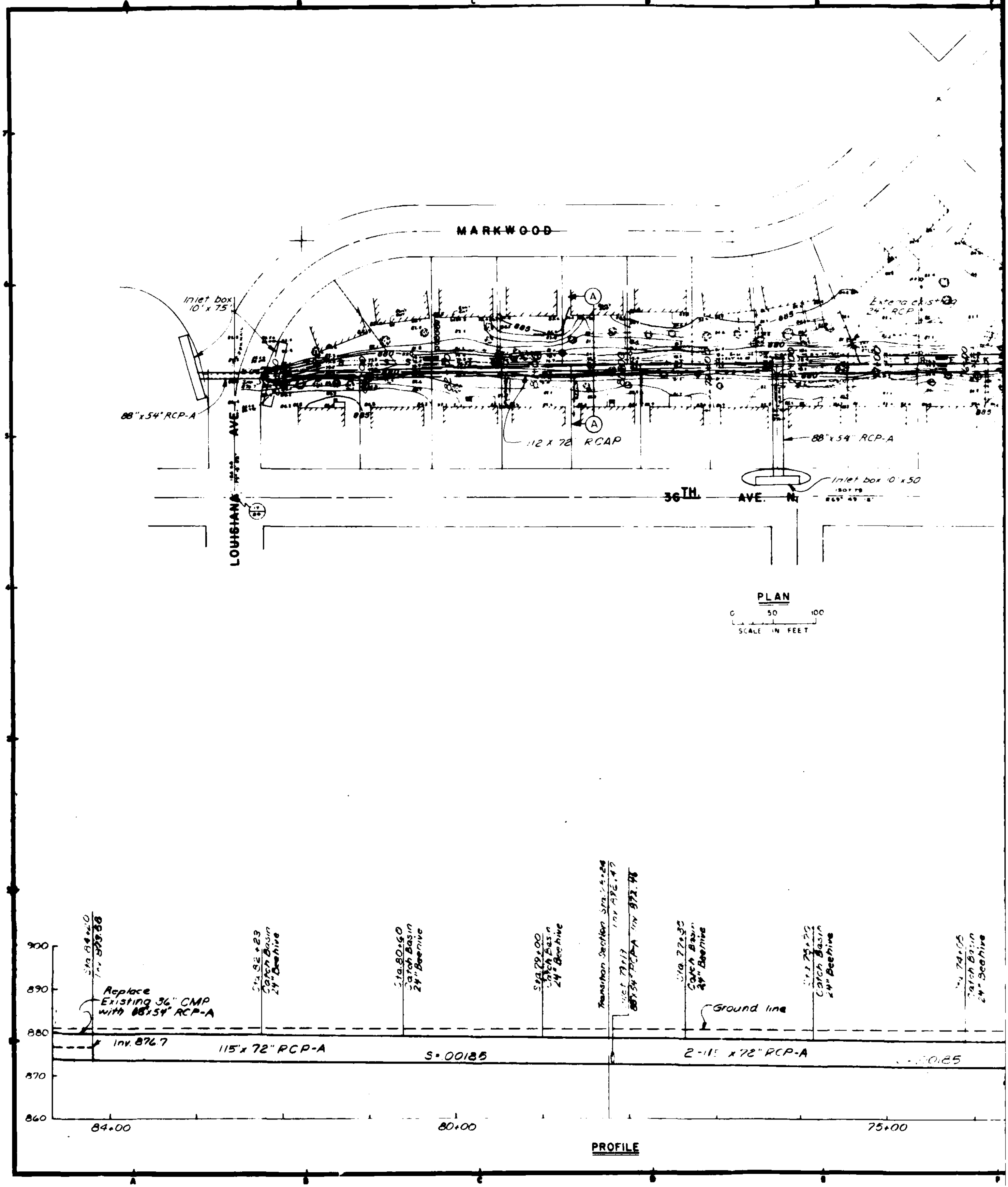
SCALE 1"=10'



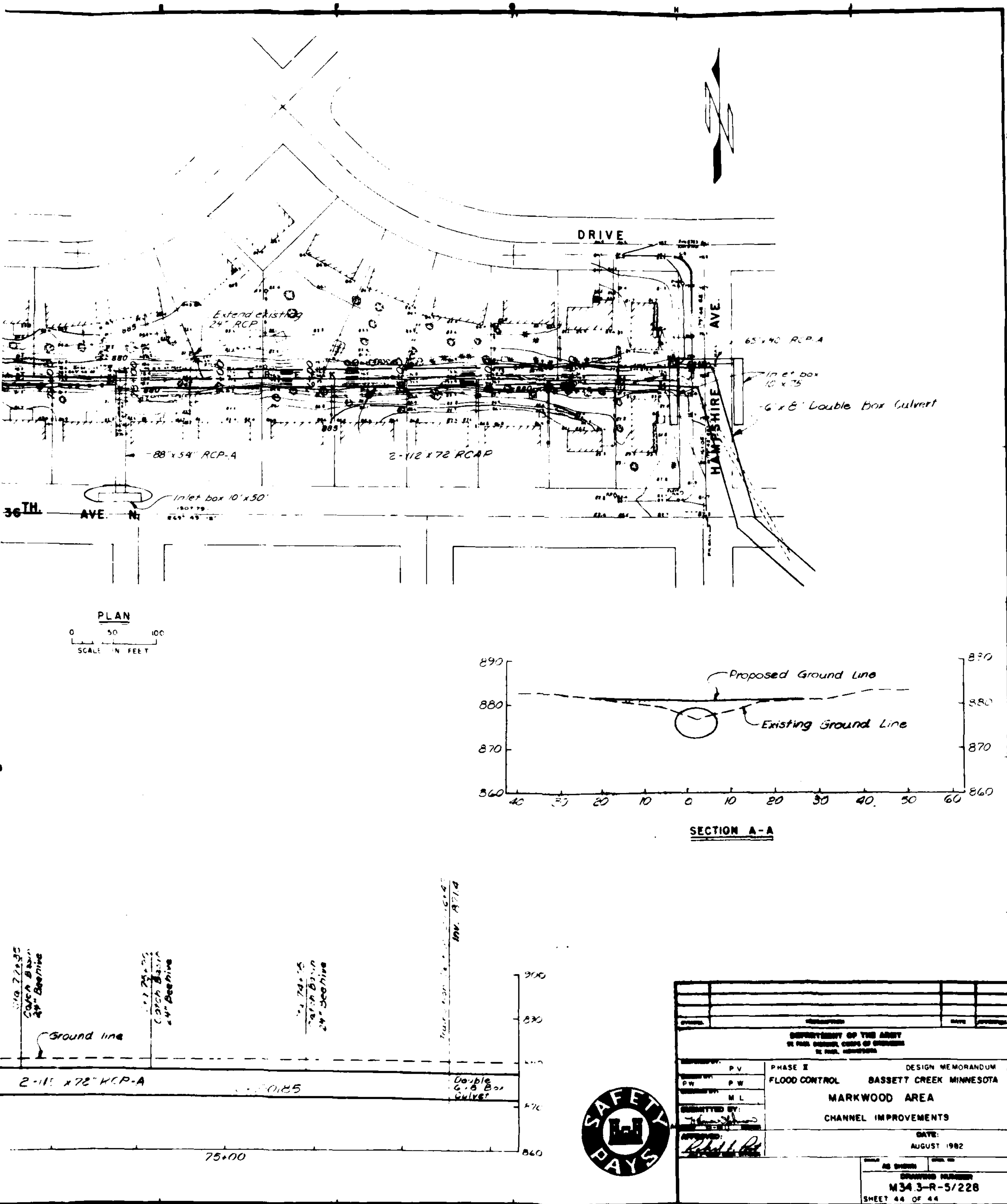
#4 B
#6
#5 BARS AT
#3 BARS A
#4
#4
#5 BARS
ST



25'
25' OR TOP OF BANK WHICHEVER IS GREATER
TOP OF RIPRAP EL 876.5
VARIES
1V TO 2H
SECTION: RIPRAP AT 36TH- HAMPSHIRE (OUTLET)
SCALE 1"=10'
SOD
SOD ALL DISTURBED AREAS
SECTION: STATION 1+05 TO STATION 1+70
SCALE 1"=10
30'
TOP OF BANK
CONC BOX
SECTION: RIPRAP AT 36TH-HAMPSHIRE (OUTLET)
SCALE 1"=10'
CB DESIGN G
INV. EL. 874.12
CB DESIGN G
880
870
874.02
874.40
28 LF 12" R.C.P. CL II AT 1.00%
10 LF 15" R.C.P. CL II AT 1.00%
NOTE: PAY LENGTH FOR 15" R.C.P. SHALL BE TO INTERIOR FACE OF BOX CULVERT WALL
DETAIL C
1+70 EL 874.13
1+50 EL 874.1
1+05 EL 871.4
TOP OF BANK RIPRAP
DOUBLE 6'x8' CONCRETE BOX
24" MIN. Mn. DOT CLASS B RIPRAP (TYP)
12" MIN. Mn. DOT TYPE 2 FILTER BLANKET (TYP)
3/43 SECTION: STATION 1+05 TO STATION 1+70
10 5 0 10 20 30 40
SCALE IN FEET
3'-0"(TYP) #3 STIRRUPS AT 3 1/2"
3" BARS AT 12"(TYP)
#4 BARS AT 9"
#6 BARS AT 6"
#5 BARS AT 12" (TYP)
#6 BARS AT 6" (TYP)
#5 BARS AT 6"
12" X 12" HAUNCH (TYP)
12" MAX RADIUS (TYP)
9"
1'-6"
8'-0"
#3 STIRRUPS AT 3"(TYP)
8"
6'-0"
1'-9"
10"
#6 BARS AT 6"
#5 BARS AT 6"
NOTE SYMMETRICAL ABOUT ℄
6/43 SECTION: 36TH AVE. BOX CULVERT
SCALE 1"=2'
80-49M
10 September 1980
SPT Blows/Ft
MC
LL PL Fines %
880
870
860
850
19
24
78
42
23
15
879.3
16
12.6
9.0
849.6
Asphalt
SP
CL 33 13
CL 26 11
SC
35
SP
SC
SP
SP
ML
SC
SP
Brn, m. dense, moist, gravelly
Brn, sandy, v. stiff, sl. plast-plast, moist
Gray, v. stiff, sl. plast-plast, sandy, till, moist
Rd brn, v. dense, sl. plast, moist
15% gravel
Brn, dense, wet
Rd brn, m. dense, wt.
Rd brn, m. dense, sl. plast, sat
Rd brn, m. dense, sat, f. gravel
2'-9"(TYP) #3 STIRRUPS AT 3 1/2"
#5 BARS AT 12"
12" X 12" HAUNCH (TYP)
12" MAX RADIUS (TYP)
9"
#3 BARS AT 12" (TYP)
#4 BARS AT 9"
8'-0"
8"
6'-0"
#4 BARS AT 6"
#5 BARS AT 12" (TYP)
1'-6"(TYP) #3 STIRRUPS AT 3 1/2"
10"
#4 BARS AT 6"
#5 BARS AT 12"
NOTE SYMMETRICAL ABOUT ℄
BC-12B
SPT Blows/Ft
880
870
860
879±
7
11
13
36
33
CL
SC
CL
Yell-brn, soft-med, fill
Dk gray-brn, sandy, till
5/43 SECTION: HAMPSHIRE AVE BOX CULVERT
2 1 0 2 4 6 8
SCALE IN FEET
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
BARR ENG CO
J.M.J
L.A.R
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
CULVERT REPLACEMENT @ 36TH AVE
DATE: AUGUST 1982
M34.3-R-5/227
SHEET 43 OF 44
PLATE 43



MARKWOOD
Inlet box 10' x 7.5'
88"x54" RCP-A
LOUISIANA AVE.
112 x 72 RCAP
88"x54" RCP-A
Inlet box 10' x 50
36TH AVE. N.
24" RCP
PLAN
0 50 100
SCALE IN FEET
Replace Existing 36" CMP with 88"x54" RCP-A
Inv. 876.7
115"x 72" RCP-A
S=.00185
2-115" x 72" RCP-A
Ground line
Catch Basin 24" Beehive
Transition Section
900
890
880
870
860
84+00
80+00
75+00
PROFILE



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

PHASE II — DESIGN MEMORANDUM
FLOOD CONTROL — BASSETT CREEK MINNESOTA

MARKWOOD AREA

CHANNEL IMPROVEMENTS

DATE: AUGUST 1982

SCALE: AS SHOWN

DRAWING NUMBER: M34.3-R-5/228

SHEET 44 OF 44

PLATE 44

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT. CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

REPLY TO
ATTENTION OF:

NCSPD-ER

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act of 1969, the St. Paul District has assessed the environmental impacts of the following action:

FLOOD CONTROL
BASSETT CREEK WATERSHED
HENNEPIN COUNTY
MINNESOTA

The proposed action incorporates several design modifications from 2nd Street North to Cedar Lake Road and at the Fruen Mill and Glenwood-Inglewood facilities, the Trunk Highway 100 flood control structure, and the Medicine Lake outlet structure. The proposed actions would have no significant impact on the social, cultural, and natural resources within the project area.

The environmental review process indicates that the proposed action does not constitute a major Federal action with significant effects on the human environment. The cumulative effects of the proposed actions are not considered significant, and their overall effects would be less than the impacts identified in the final EIS. Therefore, an environmental assessment and finding of no significant impact have been prepared instead of a supplement to the final environmental impact statement for the Bassett Creek flood control project.

Date

EDWARD G. RAPP
Colonel, Corps of Engineers
District Engineer

ENVIRONMENTAL ASSESSMENT

FLOOD CONTROL

BASSETT CREEK WATERSHED

HENNEPIN COUNTY

MINNESOTA

St. Paul District, Corps of Engineers

August 1982

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List of Tables

List of Exhibits

ENVIRONMENT ASSESSMENT
FLOOD CONTROL
BASSETT CREEK WATERSHED
HENNEPIN COUNTY
MINNESOTA

1.00 Need for and Objective of Action

1.01 Introduction - This assessment considers design layout modifications plus feature additions and deletions made to a number of project components after completion of the feasibility report in March 1976 and the final environmental impact statement (FEIS) in March 1977. These changes are a direct result of more detailed hydrologic studies and the need to lessen social disruptions. The hydrologic studies indicated that the overall scope of the proposed project could be reduced (hence lowering costs and construction activities) while maintaining sufficient flood protection. Disposal of excavated materials (including quantity, potential sites, and effects on the natural environment) is also considered in this assessment.

1.02 During Phase II studies, preparation of a supplement to the FEIS was considered. According to the Council on Environmental Quality guidelines (40 CFR 1502.9(c)), a supplement to an FEIS must be prepared if the agency makes substantial changes relevant to environmental concerns, or if significant new circumstances or information relevant to environmental concerns bear on the proposed action or its impacts. Following a detailed review and analysis of all relevant factors associated with the proposed action, the St. Paul District determined that the proposed design modifications are not substantial changes relevant to environmental concerns and that they are not significant new circumstances or information relevant to environmental concerns. Therefore, preparing an environmental assessment and finding of no significant impact is the most appropriate way to address the impacts of these design changes.

1.03 Study Authority - Authorization for the proposed project is provided by resolutions adopted by the Committee on Public Works of the United States Senate and the House of Representatives, through a review of House Document No. 669, 76th Congress, 3rd Session. The project is further authorized by the Water Resources Development Act of 1976 (Public Law 94-587).

1.04 Project Purpose - The proposed action is intended to reduce the overall scope, costs, and social disruptions of the project while maintaining its overall integrity.

2.00 Alternative Features

2.01 Project Deletions - The following features were deleted from the project after completion of the feasibility report:

1. Approximately 3,000 feet of clearing and snagging from miles 1.52 to 1.85 on the main stem.*

2. Repairs to the upstream wing walls on the Cedar Lake Road bridge.

3. Construction of a 1,020-foot floodwall and channel widening downstream from Glenwood Avenue (river miles 2.61 to 2.81) on the main stem.

4. Replacement of an existing culvert, on a side inlet channel, in Theodore Wirth Park and at Adair Avenue on the North Branch (river mile 0.57).

5. The Rice Lake floodwater storage area.

6. Riprap for approximately 200 feet of the creek channel downstream of Trunk Highway (T.H.) 100.

7. Modifications for 1,100 feet of channel from river miles 1.9 to 2.1 on the North Branch.

8. Raises for 300 feet of Dresden Lane, 1,800 feet of Toledo Avenue and West Bend Road, and 800 feet of Boone Avenue on the main stem, and 2,300 feet of Brunswick, 32nd, and Adair Avenues, and Douglas Drive on the North Branch.

2.02 Based on recent hydrologic data, items 1 and 3 through 7 were determined unnecessary for project operation; and item 2 would be accomplished by the Hennepin County Highway Department. The road raises listed under item 8 were eliminated at the request of the local sponsors.

2.03 Additions and Design Modifications - To facilitate this discussion, each of the structural features is presented under a separate category that identifies the specific construction location.

2.04 2nd Street North to Dupont Avenue - A new Bassett Creek outlet conduit would run from 2nd Street North and 3rd Avenue (beneath the proposed Interstate 394 alignment) to 6th Street North. From 6th Street North, this conduit would run diagonally under the intersection of Glenwood Avenue and Lyndale Avenue North (beneath the right-of-way of Interstate 94) to the existing outlet structure on 2nd Avenue North near Dupont Avenue. The entire length (approximately 5,950 linear feet) would be excavated as a 10-foot diameter tunnel. Tunnel excavation would be accomplished by both water-jetting and mechanical diggers. Approximately 15,000 cubic yards (yd^3) of clay and gravel plus 5,000 yd^3 of St. Peter sandstone would be removed from the tunnel.

* Miles refers to the upstream distance on the main stem or North Branch above the confluence of Bassett Creek and the Mississippi.

This tunnel would connect (at 2nd Street North) with the recently constructed Minnesota Highway Department tunnel that outflows below the St. Anthony Falls lock and dam complex (see FEIS, p. 3, paragraph 1.12, for a description and the route of this tunnel).

2.05 The planned tunnel would pass through a well developed, primarily commercial and industrial area. During construction, portions of the tunnel would need dewatering. Although this dewatering would tend to affect the ground water in those areas, the dewatering would be of short duration, with no long-lasting effects. Construction of this portion of the outlet conduit as a tunnel instead of as a surface excavation is intended principally to lessen social disruption and to avoid the many public utility lines in this area.

2.06 Dupont Avenue North to Cedar Lake Road - From Dupont Avenue North (mile 1.52) to Cedar Lake Road (mile 2.15), approximately 30 acres of land along the south side of Bassett Creek would be purchased for development of a temporary floodwater ponding area and a storage site for excavated materials. The ponding area would cover approximately 18 acres from miles 1.52 to 1.85 and would provide 90 acre-feet of floodwater storage. The remaining 12 acres, principally located between miles 1.85 and 2.15, would be used to store approximately 100,000 to 150,000 cubic yards (yd^3) of the estimated 302,000 yd^3 of material excavated from the floodwater storage area (see paragraph 2.14, on Excavated Materials, for a discussion of the characteristics of this material and the identification of alternative disposal sites). Within this area, the entire length of the Bassett Creek channel would be relocated south of the current alignment. The proposed channel would wind through the disposal site and along the north edge of the floodwater storage area. The old channel would be only partially filled so that it would retain some of the existing vegetation and drain the adjacent area.

2.07 Through this area, the Bassett Creek channel is bordered by relatively high banks composed of various types of fill material, asphalt, and concrete. Trees and brush cover the bank tops. To the north of the channel lies an industrial complex while to the south are two distinct tracts of land. One of these tracts has been used as a construction debris disposal area for approximately 30 years, and the other is a switching and storage yard owned by the Burlington Northern Railroad. The latter tract is covered predominantly by invader plant species, with only a few trees, and the first tract, a triangular-shaped disposal area, is bordered by a fairly wide band of trees. The quality of the aquatic environment through this area is rather poor because of runoff from the surrounding area. Aquatic plant and animal species are almost nonexistent in this area.

2.08 Fruen Mill and Glenwood-Inglewood Area - In addition to the planned removal and relocation of the small rock dam adjacent to the Fruen Mill, the proposed action includes several structural modifications:

1. Removal and relocation of the Minneapolis-Northfield and Southern Railroad (MN & SRR) bridge (including a portion of two spur lines) upstream from its current alignment.

2. Relocation of approximately 360 linear feet (lf) of the river channel (downstream from the MN & SRR bridge) through the existing railroad right-of-way. The old channel would be filled with riprap to stabilize a wooden retaining wall that currently protects the Glenwood-Inglewood Spring Water bottling plant some 5 feet away.

3. The stone retaining wall along the left side of the channel between the dam and railroad bridge would be replaced with a sheet-pile retaining wall. The right embankment downstream from the dam would be faced with approximately 290 lf of sheet piling and 160 lf of riprap.

4. A stormwater ponding area would be constructed east of the Glenwood-Inglewood bottling plant in an existing parking facility. This ponding area would collect runoff from the entire Fruen Mill and Glenwood-Inglewood complex. Water in the ponding area would drain into the creek through a 36-inch reinforced concrete pipe (RCP) in its southwest corner. A small earthen plug would be placed in a natural drain southeast of the proposed stormwater ponding area to prevent water from backing up during high-flow periods in the creek.

2.09 At this location Bassett Creek is characterized by a well defined channel containing a small rock dam and ponding area followed by a relatively turbulent zone with a rocky substrate. The left side of the channel consists of concrete, rock, and timber retaining walls, while the right embankment is heavily wooded and steep before it flattens out downstream and forms a grassy plain. The area surrounding the creek includes both residential and industrial properties with the latter coming within several feet of the banks. Bassett Creek water quality tends to be fairly good except for short periods when discharges and turbidity levels are high. This segment of the creek channel maintains a few minnows and a fair population of benthic invertebrates (i.e., Ephemeroptera, Tricoptera, and Diptera), some snails, and flatworms.

2.10 Trunk Highway (T.H.) 100 Floodwater Control Structure - As discussed in the FEIS, p. 6, paragraph 1.28, a flood storage structure consisting of an earthen embankment, large-diameter culverts, and an overflow weir would be constructed immediately upstream of T.H. 100. As currently proposed, the entire embankment would be relocated approximately 200 feet farther upstream to avoid utility lines (electric, sewer), to avoid altering T.H. 100 stormwater drainage patterns, and to obtain a better overall layout of the proposed structure. In addition, the south arm of the embankment would be shortened and angled toward the southwest to tie into higher ground along Dodge Road. The reach of channel between the embankment and T.H. 100 would then be excavated and straightened, and lined with stone riprap. This feature was added so that flows discharged through the embankment would approach more directly the double-box culverts beneath T.H. 100.

2.11 At this location, the area bordering the creek can be considered predominantly residential, although recreational open space areas are located immediately upstream and downstream of the proposed structure. The creek itself is ordinarily rather slow-moving, somewhat narrow (less than 5 feet), and relatively shallow. The substrate is a sandy-clay material. Aquatic life

in this reach is limited due to these conditions. The channel embankments are slightly sloping and maintain a narrow band of trees consisting of cottonwood, ash, and willow. A small portion of the embankment near T.H. 100 maintains a relatively dense cover of grass.

2.12 Medicine Lake Outlet Structure - As previously proposed, the existing outlet structure for Medicine Lake would be removed and a new control structure built adjacent to the Minnesota Western Railroad bridge located approximately 500 feet downstream from Medicine Lake (see FEIS, p. 8, paragraph 1.33). The control structure has been reduced to a 138-foot sheet-piled dam with a 13-foot wide low-flow weir. The entire structure would be built on the upstream side of the railroad bridge. Rock riprap would be placed behind the dam to prevent scour while a concrete bed would be placed beneath the railroad bridge for stability. In addition, the outlet channel from Medicine Lake to South Shore Drive would be lined with sheet piling and widened to a maximum of 35 feet.

2.13 From Medicine Lake to the site of the proposed control structure, the creek channel runs first between two residential properties and then through a relatively undisturbed Type 2/3 wetland.* The channel is well defined throughout this area and has a sandy-silt (humus) type substrate. In the residential area, the shoreline is covered with grass, while in the Type 2/3 wetland, bulrush and cattails predominate. Discharges from Medicine Lake through this area are relatively constant most of the year. Flow rates tend to increase after spring snowmelt and summer rainstorms, while minimum flow or no flow tends to occur in late winter or during long periods of dry weather. During periods of no flow, pools develop in low areas along the creekbed. Fish (mostly minnows) and benthic populations vary throughout the year, with some small game fish appearing following high discharge periods.

2.14 Excavated Materials - Of the estimated 348,000 cubic yards (yd^3) of material to be excavated during the construction of the proposed project, approximately 322,000 yd^3 must be disposed of in an approved manner. This material would principally come from two sites: the new outlet conduit (20,000 yd^3) and the tunnel inlet storage area (302,000 yd^3) (see FEIS, p. 4, paragraph 1.15). The excavated materials would consist of clay, gravel, and sand from the outlet conduit plus construction debris (concrete, asphalt, bricks, wood, and coarse gravel), clay, and humus or organic material from the tunnel inlet storage area.

2.15 Minnesota Pollution Control Agency (MPCA) records show that the inlet storage excavation area was used for many years as a construction debris disposal site. MPCA records also show that some debris from an agricultural-chemical warehouse fire was dumped at this location; however, MPCA removed all of this material and placed it in an approved disposal site. Other than this one incident, MPCA records indicate that no hazardous material or refuse has been placed at this site.

*A Type 2/3 wetland contains soils that are waterlogged to within a few inches of the surface and covered by at least 6 inches of water.

2.16 Further discussions with MPCA indicated that, because the area was an uncontrolled dump site, hazardous materials could be present. As a result, a sampling program was initiated to analyze chemically both the soils and ground water in the proposed ponding area. Samples were obtained from 10 test pits randomly selected throughout the proposed storage area. Each sampling (i.e., soil or water) was analyzed for both heavy metals and purgeable organics (see Table 3 for a list of the parameters under each of the above headings). Following the excavation of each test pit, a visual description of its contents was recorded. Most of the debris was located in layers at various depths. The most abundant type of material observed in all test pits was clay bricks, followed by glass containers of various shapes and sizes. Other materials observed included clay, cinders and ash, wood debris, reddish sand, tar, domestic rubbish (i.e., various types of containers), electrical wiring, insulation and electrical conduits, gravel, and reddish-orange soil giving the appearance of rusting metal.

2.17 The test results indicated that the material was relatively clean, except for several areas of concern. There was a general low-level presence of nickel and zinc in the filtered water samples from each of the test pits. PCB's were present in water samples from test pit 82-76. Derivatives of creosote were found in soil samples from test pits 82-73, 82-74, and 82-78. The presence of these toxic substances indicates a need for further analyses to determine if the proposed disposal methods comply with the Toxic Substance Control Act (TSCA), the Resource Conservation and Recovery Act (RCRA), and applicable State standards. These analyses will be conducted during the next stage of project planning.

2.18 It has been estimated that approximately 100,000 to 150,000 yd^3 of the excavated materials, from both the outlet conduit and tunnel inlet storage areas, could be disposed of in the vicinity of the latter area. An estimated 12 acres could be available for such disposal (if the city of Minneapolis can buy the needed land). Several alternative disposal sites have been identified for the placement of these materials:

1. Herbst and Sons Construction Co., Inc. - Demolition Landfill, T. 31N. R.23W., Section 22, in New Brighton, Minnesota.

2. Port Crosby Association

   a. T.28N., R.22W., NW 1/4 of Section 16 (80 acres) in South St. Paul, Minnesota, along the Mississippi River (river mile 835.3).

   b. T.27N., R.22W., Section 27 in Inver Grove Heights, Minnesota, along Highways 55 and 52, 10825 East Courthouse Boulevard.

2.19 Other methods that could be used for the placement of suitable fill material include:

1. Storing the material in a holding area until a suitable disposal site is identified.

2. Stockpiling some of the material such as sand and gravel for later use on areas such as winter roadways, and on lake and river shorelines as either shoreline nourishment or protection.

2.19 Most of the proposed fill site lies to the west of the tunnel inlet storage area. It consists of an open area filled with piles of construction debris and bordered by a variety of trees (e.g., elm, ash, cottonwoods) that parallel Bassett Creek to the north and the Burlington Northern Railroad tracks to the south. Immediately north of the proposed inlet storage area is the Bassett Creek channel. As currently planned, the channel in this area would be diverted through the inlet storage area and the old channel would be partially filled with clean excavated material. The material excavated from construction of the new conduit would be used for this fill.

3.00 Environmental Effects

3.01 The following is a description of the effects of the proposed modifications on the environmental resources of the area. Environmental effects associated with the construction activities outlined in section 2.00 are expected to be minor and short term. The cumulative effects of the proposed actions are expected to be less than those previously identified in the FEIS. Impact categories in Table 1 were reviewed and evaluated during the assessment of the proposed modifications. A summary of this review is presented below. Table 2 shows the relationships of the proposed project to environmental protection statutes and other environmental requirements.

3.02 Social and Cultural Effects - No appreciable social and cultural effects would result from the proposed modifications. No properties in the project area are listed on or eligible for inclusion on the National Register of Historic Places. In addition, there are not any known archaeological or historical sites that would be affected. Because of previous disturbance in the area of the proposed changes and because of previous surveys of the project, no additional surveys would be necessary prior to construction.

3.03 Social Effects - The proposed modifications to the new conduit, the Fruen Mill and Glenwood-Inglewood area, the Trunk Highway 100 embankment, and the Medicine Lake outlet structure would lessen the overall negative effects on public and private facilities and services while ensuring an adequate degree of flood protection.

3.04 Natural Resource Effects - The proposed structural modifications would affect an additional 1,700 linear feet (lf) of existing river channel in addition to those effects discussed in the FEIS, pages 28 to 38, paragraphs 4.00 to 4.43. The areas of impact include the tunnel inlet storage site (1,150 lf), the Fruen Mill and Glenwood-Inglewood site (360 lf), the T.H. 100 embankment (150 lf) site, and the Medicine Lake outlet (40 lf) site. These effects would either modify the existing substrate or eliminate the entire creekbed through relocation of the channel. At the Trunk Highway 100 embankment and the Medicine Lake outlet structure, the existing substrate

would be modified to include rock riprap. Since few benthic invertebrates inhabit the area under present conditions, addition of rock material would diversify the habitat and promote development of a more diverse grouping of benthic communities.

3.05 As discussed in paragraphs 2.06 and 2.08, item 2, approximately two sections of creek channel measuring 1,150 and 360 lf would be relocated, resulting in the loss, through burial, of the existing channel along with the aquatic communities in those areas. When completed, the new channel above the tunnel inlet storage area would contain both slack and turbulent areas, thereby producing habitat for a greater diversity of both fish and benthic communities. In the Fruen Mill and Glenwood-Inglewood area, the new channel would retain some of the qualities of the old channel (i.e., rocky substrate and turbulent water) but provide less turbulent areas with relatively smooth substrates. Hence, a more diverse assemblage of organisms would develop in this area.

3.06 Excavated Material - As discussed in paragraphs 2.14 to 2.19 of this assessment, identification of potential disposal sites for an estimated 177,000 to 222,000 yd^3 of excavated material (from the tunnel inlet storage area) became increasingly important during Phase II planning, partly because of concerns expressed by the MPCA about potential contamination of the soils to be excavated. The ponding area excavation site has been used as a demolition debris disposal area, and a portion of it is still used for such disposal. The rest of the site contains the remnants of a railroad switching and storage facility.

3.07 Chemical analyses (discussed in paragraph 2.16) were conducted to respond to MPCA's concerns and to determine if any environmentally-harmful contaminants were present. Test results (discussed in paragraph 2.17) indicated low levels of nickel, zinc, and PCB's in some of the water samples while some of the soil samples contained moderate levels of a number of creosote compounds. Even though most of the area sampled appeared relatively clean, the presence of some potentially toxic substances indicates a need for further analysis to determine if the proposed disposal methods for the excavated materials would comply with the Toxic Substance Control Act, the Resource Conservation Recovery Act, and any applicable State standards. Because of time and money limitations, these additional studies cannot be conducted until the next phase of planning. As the test results become available, the St. Paul District will assess the impacts of both the ponding area and proposed disposal methods and will prepare the appropriate National Environmental Policy Act documentation (environmental assessment, environmental impact statement supplement, or other appropriate documents).

4.00 Coordination

4.01 Throughout development of the project design modifications, coordination with the public and governmental agencies was maintained. The draft reports, including the environmental assessment and 404(b)(1) evaluation, will be sent to interested citizens, and to local, State, and Federal agencies for review and comment.

TABLE 1
ENVIRONMENTAL IMPACT ASSESSMENT MATRIX
BASSETT CREEK WATERSHED

NAME OF PARAMETER	MAGNITUDE OF PROBABLE IMPACT: INCREASING BENEFICIAL IMPACT — SIGNIFICANT	SUBSTANTIAL	MINOR	NO APPRECIABLE EFFECT	INCREASING ADVERSE IMPACT — MINOR	SUBSTANTIAL	SIGNIFICANT
A. SOCIAL EFFECTS							
1. Noise Levels				X			
2. Aesthetic Values			X				
3. Recreational Opportunities				X			
4. Transportation				X			
5. Public Health and Safety				X			
6. Community Cohesion (Sense of Unity)				X			
7. Community Growth and Development				X			
8. Business and Home Relocations			X				
9. Existing/Potential Land Use			X				
10. Controversy				X			
B. ECONOMIC EFFECTS							
1. Property Values			X				
2. Tax Revenues				X			
3. Public Facilities and Services				X			
4. Regional Growth				X			
5. Employment				X			
6. Business Activity			X				
7. Farmland/Food Supply				X			
8. Commercial Navigation				X			
9. Flooding Effects			X				
10. Energy Needs and Resources				X			
C. NATURAL RESOURCE EFFECTS							
1. Air Quality				X			
2. Terrestrial Habitat				X			
3. Wetlands				X			
4. Aquatic Habitat					X		
5. Habitat Diversity and Interspersion				X			
6. Biological Productivity				X			
7. Surface Water Quality				X			
8. Water Supply				X			
9. Groundwater				X			
10. Soils				X			
11. Threatened or Endangered Species				X			
D. CULTURAL EFFECTS							
1. Historic Architectural Values				X			
2. Prehistoric and Historic Archaeological Values				X			

TABLE 2
RELATIONSHIP OF PLANS TO ENVIRONMENTAL PROTECTION STATUTES AND OTHER ENVIRONMENTAL REQUIREMENTS
BASSETT CREEK WATERSHED
HENNEPIN COUNTY, MINNESOTA

	Plan 1[1]
Federal Statutes:	
Archaeological and Historic Preservation Act, as amended, 16 U.S.C. 469 et seq.	FC
Clean Air Act, as amended, 42 U.S.C. 7401 et seq.	FC
Clean Water Act, as amended (Federal Water Pollution Control Act) 33 U.S.C. 1251 et seq.	FC
Coastal Zone Management Act, 16 U.S.C. 1451 et seq.	NA
Endangered Species Act, as amended, 16 U.S.C. 1531 et seq.	FC
Estuary Protection Act, 16 U.S.C. 1221 et seq.	NA
Federal Water Project Recreation Act, as amended, 16 U.S.C. 460-1(12) et seq.	FC
Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 et seq.	FC
Land and Water Conservation Fund Act, as amended, 17 U.S.C. 4601 - 4601-11 et seq.	FC
Marine Protection, Research and Sanctuaries Act, 22 U.S.C. 1401 et seq.	NA
National Historic Preservation Act, as amended, 16 U.S.C. 407a et seq.	FC
National Environmental Policy Act, as amended, 42 U.S.C. 4321 et seq.	FC
Rivers and Harbors Act, 33 U.S.C. 401 et seq.	FC
Watershed Protection and Flood Preservation Act, 16 U.S.C. 1001 et seq.	NA
Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271 et seq.	FC
Executive Orders, Memoranda, etc.	
Floodplain Management (E.O. 11988)	FC
Protection of Wetlands (E.O. 11990)	FC
Environmental Effects Abroad of Major Federal Actions (E.O. 12114)	NA
Analysis of Impacts on Prime and Unique Farmlands (CEQ Memorandum, 30 August 1976)	NA
Required Federal Entitlements	
None	NA
State and Local Policies	
Minnesota Code of Agency Rules, Pollution Control Agency, WPC 14	FC
Land Use Plans	
None	NA

[1] FC - Full Compliance. The plan has met all requirements of the statute, E.O., or other environmental requirements for the current stage of planning.
PC - Partial Compliance. The plan has not met some of the requirements normally met in the current stage of planning.
NC - Non-compliance. The plan is in violation of a requirement of the statute, E.O., or other environmental requirement.
NA - Not Applicable. The statute, E.O. or other environmental requirement does not apply to the current stage of planning.

TABLE 3
CHEMICAL PARAMETERS FOR SOIL AND GROUNDWATER ANALYSIS

Purgeable Organics	Heavy Metals
Acolein	Antimony
Acrylonitrile	Arsenic
Benzene	Beryllium
Bis (2 chlorethyl) ether	Cadmium
Bromoform	Chromium
Carbon tetrachloride	Copper
Chlorobenzene	Cyanide
Chloroethane	Lead
Chloroform	Mercury
Chlorodibromomethane	Nickel
Creosote	Selenium
Dichlorobromomethane	Silver
Dichlorodifluoromethane	Thalium
Ethylbenzene	Zinc
Methylene chloride	
Methyl chloride	
Methyl bromide	
Toluene	
Trichlorofluoromethane	
Trichloroethylene	
Tetrachloroethylene	
Vinyl chloride	
2 Chloroethylvinyl ether	
1,1 Dichloroethane	
1,2 Dichloroethane	
1,1,1 Trichloroethane	
1,1,2 Trichloroethane	
1,1,2,2 Tetrachloroethane	
1,1 Dichloroethylene	
1,2 Trans-dichloroethylene	
1,2 Dichloropropane	
1,3 Dichloropropene	
Polychlorobiphenyls (totals PCB's)	
Creosote, compounds of:	
Acenaphthene	
Acenaphthylene	
Anthracene	
Benzo(a)anthracene	
Benzo(a)pyrene	
Benzo(b) fluoranthene	
Benzo(ghi)perylene	
Benzo(k)fluoranthene	
Chrysene	
Dibenzo(ah)anthracene	
Fluoranthene	
Fluorene	
Indeno(1,2,3-c,d) pyrene	
Naphthalene	
Phenanthrene	
Pyrene	

PRELIMINARY
SECTION 404(b)(1) EVALUATION
OF THE
BASSETT CREEK WATERSHED FLOOD CONTROL
PROJECT
HENNEPIN COUNTY, MINNESOTA

I. Project Description

a. Location - The proposed fill activities would take place in the main stem of Bassett Creek between its outlet from Medicine Lake and the point where the creek enters the conduit in West Minneapolis and along the North Branch Bassett Creek between its outlet from Northwood Pond and its junction with the main stem.

b. General Description - The proposed fill activities would include five types of structural measures:

(1) Complete closure and filling of stream segments in conjunction with construction of a new channel.

(2) Placement of temporary sandbag levees for stream diversion and dewatering of construction areas.

(3) Placement of riprap and riprap filters across the stream channel.

(4) Placement of sheet-pile floodwalls on one or both sides of the channel.

(5) Placement or construction of flow-control structures (weirs, culverts, drop structures, etc.) at various points along the stream.

c. Authority - These actions are undertaken through authority provided by resolutions adopted by the Committee on Public Works of the U.S. Senate on 7 April 1962 and the House of Representatives on 24 September 1970 in order to provide flood protection for areas in the Bassett Creek watershed.

d. General Description of Fill Material

(1) General Characteristics of Fill Material - Fill material would consist of sandbags (clean sand inclosed within burlap bags, riprap (quarried stone), riprap filters (crushed stone or coarse sand), sheet pile (metal), liquid and solid premixed concrete, and a silt/sand gravel soil.

(2) Quantity of Material - Approximately 100 cubic yards (yd^3) of sandbags would be required for the two temporary levees. Approximately 8,370 yd3 of rock and 2,300 yd3 of sand would be needed for the riprap and filter. The sheet metal sidewall

structures would require 800 linear feet of material. Approximately 35,000 yd^3 of the silt/sand/gravel material would be needed to fill one section of streambed.

(3) <u>Source of Material</u> - Burlap sandbags, concrete, and sheet metal would be obtained from local commercial sources. Rock and sand material would be obtained from a local State-approved source. The silt/sand/gravel material would be obtained from the St. Peter sandstone formation during the excavation of the tunnel segment of the project.

e. <u>Description of the Proposed Fill Sites</u>

(1) <u>Location</u> - Locations of the eight proposed fill sites are shown on Exhibit 1.

(2) <u>Size</u> - At sites 1 and 2, 3,250 and 360 square feet (ft^2) of stream channel, respectively, would be completely filled and covered. The area of streambed to be covered by riprap would be 7,200 ft^2 at site 3, 1,600 ft^2 at site 5, 900 ft^2 at site 6, 4,140 ft^2 at site 7, and 1,800 ft^2 at site 9. A total of 8,100 ft^2 of stream channel would be covered by new structures (weirs, culverts, drop structures, etc.) at sites 2, 3, 4, 5, 6, 7, and 8. During construction, approximately 400 ft^2 of streambed would be covered by temporary sandbag levees at sites 4 and 6.

(3) <u>Type of Site</u> - Fill placed behind the temporary levees at sites 4 and 6 would be confined. All other fill activities would be carried out in unconfined open water areas.

(4) <u>Types of Habitat</u> - All of the proposed sites are located along the main stem or the North Branch of Bassett Creek, a small, gradually-sloped stream. Site 1 is located in an area of high industrial development and has a degraded aquatic environment. Sites 2, 3, 4, 5, 6, and 8 are located in areas of moderate to heavy residential development. Although the habitat present provides aesthetically pleasing areas, it has been significantly altered from an undisturbed state. Most of the area surrounding site 7 is a Type 2/3 wetland* and is relatively undisturbed.

(5) <u>Timing and Duration of Discharge</u> - Construction activities would be scheduled between March 1984 and December 1986, during periods of moderate to low flows.

* A Type 2/3 wetland contains soils that are waterlogged to within a few inches of the surface and covered by at least 6 inches of water.

II. Factual Determinations

a. Physical Substrate Determinations

(1) Substrate Elevation and Slope - The proposed fill activities would have no significant impact on the creek's slope or elevation except for the probable development of small pools immediately above or below the flow-regulation structures. Fill placed at sites 1 and 2 would completely close off the channel, but related project activities would construct a nearby channel with approximately the same slope and relative elevation.

(2) Sediment Type - Placement of rock, concrete, and gravel would significantly change or alter the project area's existing sediment type (silt/sand).

(3) Dredged/Fill Material Movement - The size of the fill material would be large enough and the stream velocity low enough during construction to ensure that no significant movement of fill material would occur.

(4) Physical Effects on Benthic Organisms - A complete and permanent loss of existing benthos would occur in those areas covered at sites 1 and 2. The new channels constructed in conjunction with these fill activities, however, would eventually support a similar benthic assemblage. The riprap placed at sites 3, 4, 5, 6, 7, and 8 would eliminate or displace some benthic organisms but would probably have a positive long-term impact by providing for a more diverse habitat. The cement structures at sites 3, 4, 5, 6, 7, and 8 would destroy any habitat that they cover and would provide minimal replacement habitat. The sheet-pile structures at sites 2 and 7 would eliminate a certain amount of bank habitat. The temporary levees around construction areas at sites 4 and 6 would have a short-term negative impact on the habitat that they covered. These affected areas would probably recover quickly, however, once the levees were removed.

(5) Actions Taken to Minimize Impacts - Clean fill material would be used and, whenever possible, construction would be carried out at low-flow periods.

b. Water Circulation, Fluctuation, and Salinity Determinations

(1) Water

(a) Salinity - Not applicable.

(b) Water Chemistry, Color, Odor, Taste, Dissolved Gas Levels, Nutrients, Eutrophication, and Temperature - The proposed fill activities should have no significant impact on any of these parameters.

(c) Clarity - Some increase in turbidity may be caused by construction activities associated with the fill discharge, but this would be a short-term situation minimized by the use of clean fill material and temporary levees to inclose major construction areas.

(2) Current Patterns and Circulation

(a) Current Patterns and Flow - Fill activities at sites 1 and 2 are designed to move the channel and therefore the current pattern from its existing position. The permanent ponding area at site 1 would slow the creek's flow through this area. Flow-control structures at sites 1, 3, 4, 6, and 7 would temporarily hold water behind them at times of high flow.

(b) Velocity - During high-flow periods, the structures at sites 1, 3, 4, 6, and 7 would lessen flows by diverting some of the water into ponding areas.

(c) Stratification and Hydrologic Regime - The proposed fill activities would have no significant impact on either stratification or hydrologic regime.

(3) Normal Water Level Fluctuations - The proposed retarding structures would increase the stage levels in the ponding areas but decrease these levels downstream.

(4) Salinity Gradient - Not applicable.

(5) Actions Taken to Minimize Impacts - Clean fill material would be used to minimize the potential for negative water quality impacts. At sites 4 and 6 where major fill activities would take place, temporary levees would be constructed to dewater the areas, thus reducing the chance for negative impacts on the environment.

c. Suspended Particulate/Turbidity Determinations - The fill material used at site 1 would be a mixture of silt, sand, and gravel. Although the silty material would be susceptible to resuspension, it would still not be considered suspended particulate matter. In addition, the nature of the fill action would leave all but a small portion of this material protected from the force of the flowing water. The fill material to be used at the other sites would be sand or larger particle size mineral substances. This fill would contain no significant amounts of suspendable particulate or organic matter. Because of these conditions, no significant increase would be expected in turbidity or in the concentration of suspended particulates caused by project activities.

d. Contiminent Determinations - The proposed fill materials -- clean silt, sand, gravel, rock, and cement -- would not introduce contaminants into the aquatic system. Likewise, neither the materials nor the placement would significantly relocate or increase contaminants already in the aquatic system.

e. Aquatic Ecosystem and Organism Determinations

(1) Effects on Plankton - Lentic areas established behind retarding structures and in ponding areas would provide improved habitat for plankton.

(2) Effects on Benthos - Some benthic organisms would be killed or displaced by the project's permanent and temporary fill activities. This impact would be short term in areas where the fill material would be removed. Areas that would be covered by rock and gravel would probably provide better benthic habitat than the present predominantly silt/sand substrate. The cement structures would provide little replacement habitat.

(3) Effects on Nekton - Placement of the flow control structures could impede or prevent migration of various nektonic species through the project area. The relative importance of this impact would be minimal, however, because of the limited number of such organisms which inhabit the area.

(4) Effects on Aquatic Flood Web - Placement of fill material would have no significant impact on the project area's food web.

(5) Effects on Wetlands - The structure at site 8 would change approximately 0.5 acre of Type 2/3 wetland to Type 3/4 wetland.*

(6) Threatened and Endangered Species - The proposed fill activities would have no significant impact on any threatened or endangered species.

(7) Actions to Minimize Impacts - Clean fill material would be used in all cases. The temporary levees would be made of sandbags to facilitate levee removal. Fill and construction activities would take place as much as possible during low-flow periods.

f. Proposed Disposal Site Determinations

(1) Mixing Zone Determinations - The maximum depth of the creek in areas that would receive fill material is 3 feet. The fill would be placed during periods of low flow, be protected by temporary levees in certain cases, be free of contaminants, and consist primarily of sand, gravel, rock, and premixed concrete, which would all quickly come out of suspension. Some silt would be in the fill placed at site 1 but the placement method and the small amount of silt present indicate that only a small quantity of material would go into and remain in suspension. Under these conditions, the mixing zone would be acceptable.

*A Type 3/4 wetland contains soil that is waterlogged throughout the growing season and is usually covered with 6 inches to 3 feet or more of water.

(2) Determination of Compliance With Applicable Water Quality Standards - The Minnesota Pollution Control Agency has classified Bassett Creek in Fisheries and Recreation Category (2B). This classification requires water of a quality adequate to propagate and maintain both sport and commercial fishes as well as aquatic recreation of all kinds, including swimming. The fill material would be obtained from uncontaminated sources; selected sites would be protected by temporary levees during fill placement; and, whenever possible, fill would be placed during low-flow periods. These procedures should insure that water quality conditions remain within a range acceptable to State regulatory agencies.

(3) Potential Effects on Human Use Characteristics - It has been determined that there would be no potential for significant effects on human use characteristics, based on the present and projected human use characteristics, existing physical conditions, the proposed construction methods, and the clean nature of the fill material.

(4) Determination of Cumulative Effects on the Aquatic Ecosystem - The cumulative impact of the proposed fill activities would include:

(a) A reduction in flow velocity in Bassett Creek.

(b) Temporary increases in stage levels behind the new structures at sites 3, 4, 6, and 7.

(c) Short-term increases in turbidity caused by construction activities.

g. Determination of Secondary Effects on the Aquatic Ecosystem - Secondary impacts associated with the proposed fill activities include:

(1) A long-term reduction in turbidity due to a reduction in bank erosion and the settling that would occur in the ponding areas.

(2) A possible reduction in water quality due to ponding of nutrient-rich water behind the flow control structures.

III. Findings of Compliance or Noncompliance With the Restrictions on Discharge - The proposed fill activities would comply with the Section 404(b)(1) Guidelines of the Clean Water Act. Of the alternatives considered, only plans 4C, 6C, and 6D satisfied the economic requirement of practicability, a benefit/cost ratio of 1.00 or greater (i.e., benefits must equal or exceed costs). Plan 4A would have had greater negative environmental impact than would the selected plan, 6C. The environmental impacts of Plans 6C and 6D are identical, but 6C has better engineering aspects.

The proposed fill activities could result in turbidity readings temporarily in excess of the State standards, but this impact would be a short-term condition associated with construction activities. The proposed action would comply with Section 307 of the Clean Water Act and the Endangered Species Act of 1973, as amended. The proposed fill activity would have no significant adverse impact on human health or welfare. To minimize the potential for adverse impacts, clean fill would be used; construction would take place during periods of low flow; and, where practicable, temporary levees would be placed around construction sites. On the basis of this evaluation, the proposed disposal sites are specified as complying with the requirements of the guidelines for discharge of fill material.

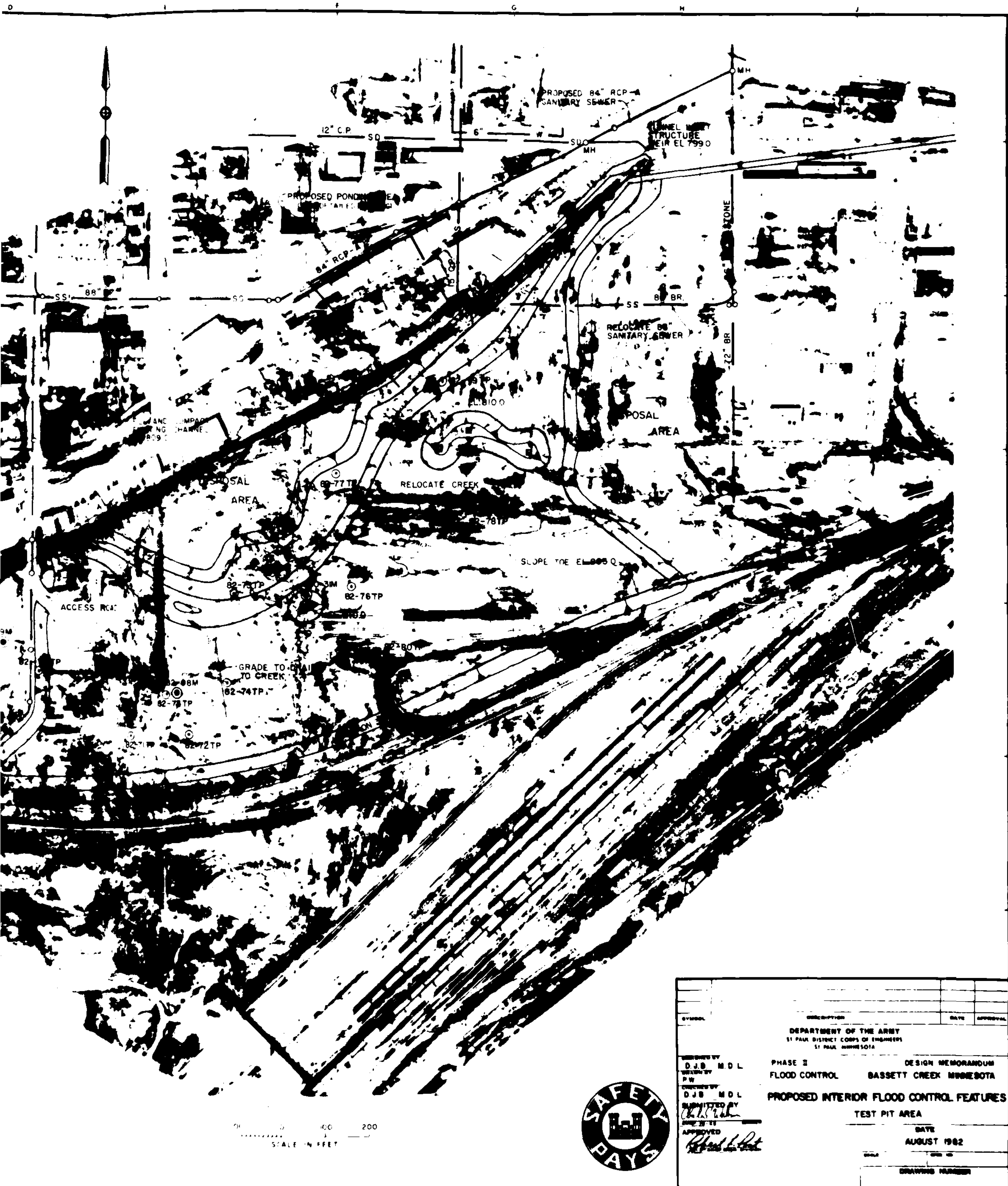
16 Sep 82

Date

Edward G. Rapp

EDWARD G. RAPP
Colonel, Corps of Engineers
District Engineer


ACCESS ROAD
82-69M
82-67M
27" C.P.
42" C.P.
AREA
82-74TP
82-72TP
GRADE TO
TO CREEK
PROPOSED PONDING AREA
DETAILED DRAWING
SCALE IN FEET


PROPOSED 84" RCP
SANITARY SEWER
12" C.P.
SD
6"
MH
TUNNEL INLET STRUCTURE WEIR EL 799.0
PROPOSED PONDING AREA
84" RCP
88"
SS
88" BR.
RELOCATE 88" SANITARY SEWER
72" BR
STONE
EL 810.0
DISPOSAL AREA
RELOCATE CREEK
82-77TP
82-78TP
SLOPE TOE EL 805.0
82-75TP
82-76TP
ACCESS ROAD
82-80TP
GRADE TO DRAIN TO CREEK
82-68M
82-73TP
82-74TP
82-72TP
0 50 100 200
SCALE IN FEET
SAFETY PAYS
SYMBOL
DESCRIPTION
DATE
APPROVAL
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
DESIGNED BY D.J.B. M.D.L.
DRAWN BY P.W.
CHECKED BY D.J.B. M.D.L.
SUBMITTED BY
APPROVED
PHASE II
DESIGN MEMORANDUM
FLOOD CONTROL
BASSETT CREEK MINNESOTA
PROPOSED INTERIOR FLOOD CONTROL FEATURES
TEST PIT AREA
DATE
AUGUST 1982
DRAWING NUMBER
SHEET OF

NEPA PLATE I

DEPARTMENT OF THE ARMY
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX A

HYDRAULICS

Table of Contents

Tables

Plates

APPENDIX A

GENERAL

1. Because the presented project is basically the same as previously defined in Design Memorandum No. 1, only changes from the original design are presented in this appendix. The changes concern:

a. Medicine Lake Outlet Structure.

b. Golden Valley Golf Course Control Structure.

c. Highway 100 Control Structure.

d. Fruen Mill Channel Improvement.

e. New Drop Structure upstream of the Tunnel's Ponding Area.

f. Tunnel Inlet Structure and Pond.

g. Edgewood Control Structure.

2. MEDICINE LAKE OUTLET STRUCTURE

Because of potential settlement problems, the previously proposed 150-foot overflow embankment was replaced by a 185-foot sheet pile structure with a concrete cap, tied to the existing railroad embankment. The concrete 13-foot weir was also replaced by sheet piling with a concrete cap. The existing railroad bridge is also slightly modified to increase its capacity and to eliminate the two previously proposed additional RCPA's. The creek channel between Medicine Lake and South Shore Drive is widened to 35-foot bottom width to decrease friction losses. New data on the Medicine Lake Outlet are given in Tables A-1 and A-2 and on Plate A-34.

3. GOLDEN VALLEY GOLF COURSE CONTROL STRUCTURE

The control structure proposed in Design Memorandum No. 1 was redesigned for reasons of economy and better protection of the overflow embankment and river bottom downstream of the structure. The 25-foot long broad crested weir and 1 - 73" x 45" and 1 - 88" x 55" RCPA were replaced by a 75-foot long trapezoidal broad crested weir and 2 - 4' x 6' concrete box culverts. A scour hole type stilling basin was added. New data on the Golden Valley Golf Course Control Structure are given in Tables A-1 and A-2 and on Plates A-29 and A-30. The preformed scour hole stilling basin is designed in accordance with USAE WES MPH-72-5.

4. HIGHWAY 100 CONTROL STRUCTURE

For reasons of economy, the control structure was moved upstream of its location in Design Memorandum No. 1. The details of the structure are unchanged. Moving the structure allowed for shorter embankments. Details are shown on Plates A-23 and A-24.

5. FRUEN MILL CHANNEL IMPROVEMENT

To reduce costs the ogee dam and stilling basin proposed in Design Memorandum No. 1 was replaced with a straight drop structure and stilling basin designed in accordance with USAE WES HDC 623. Details are shown on Plates A-15 to A-19.

6. DROP STRUCTURE UPSTREAM OF TUNNEL PONDING AREA

To obtain the required storage area at the tunnel inlet, it was necessary to lower the channel bottom. A drop structure is presently proposed at the upstream end of the ponding area to return the bottom elevation to the natural condition. Details of this structure were not contained in Design Memorandum No. 1. The structure is designed in accordance with USAE WES HDC 624. Details of this structure are shown in Tables A-1 and A-2 and on Plate A-11.

7. TUNNEL INLET STRUCTURE AND POND

More detailed investigation subsequent to Design Memorandum No. 1 found that the design pond elevation upstream of the tunnel inlet should be lowered one foot, from 807.5 to 806.5, to give adequate freeboard on the left bank. The weir at the inlet structure was lowered from elevation 800 to elevation 799 to accomplish this. Outflow discharge hydrographs from the pond were unaffected. Details of the structure are shown in Tables A-1 and A-2 and on Plate A-9.

8. EDGEWOOD CONTROL STRUCTURE

The proposed design of the Edgewood Avenue control structure has been changed from that approved in Design Memorandum No. 1, Hydrology and Hydraulics. The structure has been changed from a non-overflow to an overflow embankment. This was done to save costs and to increase safety. The hydraulic design for the proposed overflow embankment follows.

9. The design presented in D.M. No. 1 consisted of a 40-foot fixed crest concrete drop inlet, double 169" x 107" RCPA's out of the drop inlet, a low flow 73" x 45" RCPA into the drop inlet and an embankment with a top elevation 3 feet above the probable maximum flood headwater elevation. The presently proposed design consists of a 73" x 45" RCPA transitioning to a 102" x 62" RCPA, a protected overflow embankment with a 127-foot crest at about 1 foot above the 100-year flood headwater elevation, and erosion protection at the outlet of the 73" x 45" RCPA. The proposed design is shown on Plates A-38 and A-39. As shown in Table 24 of D.M. No. 1, the non-overflow structure was classified as high hazard; the proposed overflow structure is similarly classified as high hazard and erosion protection is designed to be stable for all floods up to the probable maximum flood. It is felt the proposed overflow structure has a smaller chance of catastrophic failure than the design presented in D.M. No. 1. The previous structure was designed to have all flow through the pipes. If the drop inlet or the pipes were to plug, the embankment would be overtopped by floods. Since it was not to be protected from overtopping, there would be a risk of catastrophic failure. The presently proposed structure should be safer since it is designed to not fail when overtopped and the crest is about 8 feet lower than the non-overtopping design, reducing the size of the potential flood wave.

10. TAILWATER RATING CURVE

The tailwater rating curve at the Edgewood control structure is based on proposed conditions at downstream crossings. The headwater rating curve for Douglas Avenue (about 250 feet downstream) is used for the tailwater curve for the control structure. For large floods, the tailwater at Douglas Drive is equal to the headwater at the 34th Avenue crossing. The headwater curve at 34th Avenue is based on the proposed 115" x 72" RCPA. Headwater elevations at 34th Avenue are determined from storage outflow routings using the existing storage area from 34th Avenue to Douglas Drive. Weir flow starts at Douglas Drive at elevation 869.3 and when the headwater at 34th Avenue is greater than about elevation 871, there is negligible head loss across Douglas Drive, and the headwater for Douglas Drive is assumed equal to the headwater for 34th Avenue. The storage and rating curves for 34th Avenue are shown on Plates A-1 and A-2, respectively. Inflow and outflow hydrographs for the 34th Avenue ponding area are shown on Plates A-3 and A-4 for the standard project and probable maximum floods. The headwater rating curve for Douglas Drive (used for tailwater for the Edgewood control structure) is shown on Plate A-5.

11. STORAGE CURVE

The storage curve for the ponding area above the Edgewood control structure is based on removal of one home at the corner of Florida Avenue and 36th Avenue, removal of the Florida Avenue crossing and excavation of the storage area. The storage area is excavated to give a total storage of 19.8 acre-feet at elevation 880.0. The curve is shown on Plate A-6. The storage area is shown in plan view on Plate 40. As described in paragraphs 93, 94, 145A and 145B of D.M. No. 1, easements to preserve the storage area will be required up to a ground elevation equal to the design flood headwater elevation 879.3. Plate A-6 also shows the storage required to be preserved by easement. The area above ground elevation 879.3 is very developed. Thus, the existing total storage curve is considered to be acceptable for representing future project conditions and was used for the standard project and probable maximum flood routings.

12. HEADWATER RATING CURVE

The proposed headwater rating curve, Plate A-7, is a combination of flow through the outlet pipe and over the embankment. For flows less than about 310 cfs, all flows are through the pipe and it operates under inlet control. The computations for a discharge of 300 cfs are shown on Pages A-7 and A-8. The larger 102" x 62" RCPA is used at the outlet to reduce outflow velocities. For discharges larger than about 310 cfs, the headwater exceeds elevation 880.0, and the embankment is overtopped. The top of the embankment is 127 feet long at elevation 880.0. The weir coefficient and submergence impact were obtained from "Hydraulics of Bridge Waterways" by the BPR. The selected weir coefficient is 3.05.

13. FLOOD ROUTING

The design, standard project, and probable maximum floods were routed through the storage area using the total storage curve on Plate A-6 and the headwater rating curve on Plate A-7. A storage routing or modified Puls method was used. The inflow and outflow hydrographs are shown on Plates A-8, A-9, and A-10. Peak discharges are summarized below.

Flood	Peak Discharge Inflow	Peak Discharge Outflow	Peak Stage
Design	700	310	879.3
SPF	1044	800	881.1
PMF	2915	2000	882.7

Stage hydrographs for the headwater and tailwater for the Edgewood control structure and the headwater for 34th Avenue are shown on Plates A-11 and A-12 for the SPF and PMF. The tailwater for Edgewood is equal to the headwater for Douglas Drive.

14. OVERTOPPING PROTECTION

The proposed protection is designed to remain stable for floods up to the probable maximum flood. The stability of the proposed gabions was checked by ETL 1110-2-194. Riprap size for an alternative design was found using USAE WES TR 2-650. Velocities down the slope and location of the hydraulic jump were found by downwater computations using Chezy's equation with k set equal to 0.25 foot for the concrete-faced gabions and set equal to the riprap min D_{50} for the riprap alternative. For both alternatives, it was assumed that a maximum settlement of 0.5 foot could occur in the embankment, causing concentration of flow. Thus, the unit discharge used to size the erosion protection was found by assuming the weir crest was 0.5 foot below the average crest elevation, or at 879.5 instead of 880.0. The downstream slope of 1V:4H was based on the results of TR 2-650, page 2, paragraph 4. Normal flow velocities were found to be only 1-2 fps less for a 1V:6H slope, and thus the flatter slope was not considered necessary.

15. From Plate A-12, it can be seen that the tailwater increases rapidly with time after flow over the embankment starts. Because of this it was not obvious what was the worst case. Thus, several different time periods were checked. A downwater was performed for the peak discharge and the location of the hydraulic jump and maximum velocity were found. This was then compared to the normal depth velocities for lesser discharges that would occur earlier when the tailwater is low. It was found that the velocities reached for the peak discharge were higher than normal velocities for the smaller discharges.

Alternatives

	Gabion	Riprap
k (Chezy's)	0.25 ft.	1.56 ft.
Q (peak)	1700	1700
Hw	882.7	882.7
Tw	880.8	880.8
q (crest = 880.0)	13.4 cfs/ft	13.4 cfs/ft
q (crest - 789.5)	17.3 cfs/ft	17.3 cfs/ft
V max (at jump)	17.3 fps	14.5 fps
Horizontal Distance to jump (from edge of crest)	13 ft	9 ft

16. To determine the riprap size needed for the riprap alternative, Plate 47 of TR 2-650 was used. Several different time periods were checked and it was found that a W_{50} rock size somewhat larger than that used in the model (W_{50} = 200 bls ±) was needed. A 48-inch layer with W_{50} = 328 bls. from Inclosure 3 of the ETL 1110-2-120 was selected.

17. The stability of the concrete covered gabions was checked by ETL 1110-2-194, Plate 5. The gabions were found to be well within the stable zone; thus the use of 1V:4H downstream slope in lieu of the model's 1V:6H slope is considered acceptable.

18. STILLING BASIN AT PIPE OUTLET

A preformed scour hole is proposed at the outlet of the 102" x 62" pipe. The size of the hole and the riprap was obtained from USAE WES H-72-5, Figures 11 and 12.

19. THE OVERFLOW EMBANKMENT SECTION

The concrete-faced gabion basket alternative was chosen over the riprap alternative because it offers better overtopping protection and is more aesthetically acceptable. A typical embankment section and plan view for this alternative is shown on Plates 38 and 39. The embankment will have a top width of 20 feet, an average height of about 10 feet and a 1V on 3H upstream side slope. Twelve-inch gabion baskets on 6 inches of bedding will be placed across the top of the embankment and down the downstream slope. The baskets will be covered with 3± inches of concrete to act as a wearing surface during overtopping. The concrete will also protect and extend the life of the exposed gabion wires. The gabion baskets will be placed on a 1V on 4H downstream slope to either elevation 870.0 or the ground surface, whichever is the higher elevation. At that point, the slope of the gabions changes to 1V on 2½H to a vertical depth of 5 feet. This protection will extend the length of the embankment and continue up the abutment to elevation 886, 3 feet above the probable maximum flood level.

20. For aesthetic reasons, the concrete faced gabion baskets will be covered by 11 inches of erosion resistant clay having a liquid limit greater than 30

and a plasticity index greater than 15. Four inches of seeded topsoil will be placed over this. Four feet downstream of the embankment centerline, the gabion basket blanket will be interrupted by a concrete section having a top elevation of 880.0, extending the length of the embankment and acting as an overflow weir. To help maintain the top of the concrete weir at a permanent elevation, 8-foot long steel sheetpiling will be driven into the embankment and embedded into the concrete.

21. The embankment will be constructed of impervious fill obtained from the borrow area upstream of the embankment. The existing ground surface will be stripped to a depth of 9 inches except where layers of organic materials exist at the surface, in which case excavation will be required to suitable material.

22. RATING CURVES

All redesigned structures were hydraulically designed for "no change" in headwater elevations in comparison with structures presented and approved in Design Memorandum No. 1. For this reason there are no significant changes in the rating curves presented in Design Memorandum No. 1.

23. DISCHARGES

A summary of design (1% exceedence frequency) and standard project flood discharges are shown on Table A-3. The data on this table are taken from Table 21 of Design Memorandum No. 1, Hydrology and Hydraulics.

24. RIPRAP

A summary of hydraulic data for the design of riprap is shown on Table A-4.

25. REFERENCES

a. "Hydraulics of Bridge Waterways," U.S. Department of Transportation, Federal Highway Administration, March 1978.

b. ETL 1110-1-194, Gabion Channel Control Structures, 30 August 1974.

c. USAE WES R 2-650, Stability of Riprap and Discharge Characteristics, Overflow Embankments, Arkansas River, Arkansas, June 1964.

d. ETL 1110-2-120, Additional Guidance for Riprap Channel Protection, 14 May 1971.

e. USAE WES H-72-5, Practical Guidance for Estimating and Controlling Erosion at Culvert Outlets, May 1972.

COMPUTATION SHEET

Date	Page
12 JAN 82	2 of

Name of Office	Project
NCSED-GH	Bassett Creek

H.W at Edgewood for Q = 300 cfs

Computed by	Checked by	Approved by	Price Level
RMF			

Data

Q 300 cfs $R_{73\times45}$ =
TW - 868.65 $R_{102\times62}$ =
72' - 73" × 45" - Inlet invert = 865.7
60' - 102" × 62" - Outlet invert = 865.0

Outlet Control

For 102" × 62" Ave depth = 868.65 - 865 = 3.65'
From hydraulic elements for RCPA

A = 26.3 + .3(29.9 - 26.3) = 27.4 $^{\square'}$
R = 1.86 + .3(1.90 - 1.86) = 1.87'
V = 10.95 fps

$$h_{Lf} = \frac{29.2\,n^2}{2g}\frac{L\,V^2}{R^{4/3}} = \frac{29.2(.015)^2}{64.4}\frac{(60)(10.95)^2}{(1.87)^{4/3}}$$

= .32'

Expansion $h_e = .2\left(\Delta\frac{V^2}{2g}\right) = .2\left(\frac{16.9^2}{64.4} - \frac{10.95^2}{64.4}\right) = .52'$

73" × 45" - full

$$h_{Lf} = \frac{29.2(.015)^2}{64.4}\frac{(72)(16.95)^2}{(1.13)^{4/3}} = 1.79'$$

Outlet

$$h_o = \frac{V_1^2}{2g} = \frac{10.95^2}{2g} = 1.86'$$

Inlet $h_e = .8\frac{V_1^2}{2g} = .8\frac{(16.95)^2}{64.4} = 3.57'$

h_{TOT} = .32 + .52 + 1.79 + 1.86 + 3.57 = 8.06'

HW = 8.06 + 868.65 = 876.7

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1 NOV 1976

COMPUTATION SHEET

Date	Page 2 of 2

Name of Office	Project

Computed by	Checked by	Approved by	Price Level

Inlet Control

For $Q = 300$ cfs, 73" x 45" RCPA, Square edge

Get $\frac{HW}{D} = 3.55$ from nomograph

$$HW = \frac{(3.55)(45")}{12} = 13.3'$$

$$HW = 13.3 + 865.7 = \boxed{879.0}$$

$879.0 > 876.7 \therefore$ Inlet control

NCS FORM 34
1 NOV 1976

TABLE A-1

CONTROL STRUCTURES - DESCRIPTION

Control Structure	Station	Main Weir	Low Flow	Outlet	Embankment
Conduit Inlet	80+07	11.6' weir at El. 800.0	None	10' diameter conduit invert at El. 765.3	None-additional storage from excavation
Pond Inlet	95+00	23' weir at El. 805.0	None	23'x30' stilling basin	None
Highway 55	163+80	10' weir at El. 820.5 40' weir at El. 825.5	6' wide notch at El. 816.5	Existing 8'x10' double box, invert at El. 814.16	Existing Highway 55, low point at El. 826.6
Highway 100	350+73	Drop box 105' (75'x15') at El. 848.4	3' high x 10' wide orifice invert at El. 838.0	8'x10' double box	Top El. 851.0 to 853.5
Golden Valley Golf Course	466+70	75' trapezoidal broad-crested weir at El. 874.5 2-4'x6' concrete box culverts, invert at El. 866.5	None	2-4'x6' concrete box culverts, invert to El. 866.4	Earth embankment with 10' top width at El. 877.0
Wisconsin Avenue	525+15	Drop box - 20' (6'x8') at El. 885.5	2' high x 3.5' wide orifice, invert at El. 878.9	6'x8' box, invert at El. 878.9	Minimum top El. 889.0
Medicine Lake	675+80	13' sharp-crested weir at El. 887.7 185' sharp-crested weir at El. 889.1	13' sharp-crested weir at El. 887.7	The existing railroad bridge slightly modified by removing all soil and old timber walls to El. 885.0 and to the total bottom width 26.7'. Concrete slab 10' thick below El. 855.0	185' overflow sheet piling wall tied to existing railroad embankment
Edgewood Avenue (North Branch)	57+80	127' weir at El. 880.0 73"x45" RCPA transitioning to a 102"x62" RCPA at El. 865.7	73"x45" RCPA transitioning to 102"x62" RCPA invert to El. 865.7	102"x62" RCPA at El. 865.0	Protected overflow embankment with a 127' crest at El. 886.0

TABLE A-2 Control Structures - Hydraulic Data

Control Structure	Station	100-YEAR FLOOD: DISCHARGE (cfs) Inflow to Pond	Outflow Through Structure	TAILWATER Proposed	Existing	HEADWATER Proposed	Existing	Storage (ac-ft) Proposed	Outlet Velocity (fps) Design	STANDARD PROJECT FLOOD: DISCHARGE (cfs) Inflow to Pond	Outflow Through Structure	TAILWATER Proposed	Existing	HEADWATER Proposed	Existing	Storage (ac-ft) Proposed
Conduit Inlet	80+07	1,124	660	791.5	---	806.5	812.4	91	8.4	2,050	934	818.9	---	822.3	822.3	2,700
Pond Inlet	95+00	1,124	1,124	806.5	---	811.5	---	---	5.1	2,050	2,050	822.3	---	822.3	822.3	---
Highway 55	163+80	3,040	621	821.6	822.8	825.5	825.3	630	3.9	4,939	2,100	825.6	826.1	827.3	827.3	990
Highway 100	350+20	2,610	950	843.3	845.7	849.9	845.0	205	5.9	4,020	3,264	850.4	852.2	853.5	852.5	297
Golden Valley Golf Course	466+70	919	420	872.2	875.3	874.3	875.6	29	8.8	1,623	1,135	876.4	880.1	877.2	880.1	63
Wisconsin Avenue	525+15	3,000	370	885.1	888.1	888.8	888.2	450	7.7	4,006	1,075	890.4	890.4	890.5	890.5	1,020
Medicine Lake	675+80	9,458	245	889.5	889.5	889.7	890.1	2,000	2.5	15,873	530	890.9	891.9	891.3	891.9	5,580
Edgewood Avenue (North Branch)	57+80	700	300	868.7	877.0	879.0	877.0	18.5	2.8	1,040	676	870.9	878.5	881.2	878.5	29

TABLE A-3
COMPARISON OF DISCHARGES
ULTIMATE DEVELOPMENT VERSUS ULTIMATE DEVELOPMENT WITH PROJECT

Subwatershed Designation		100-Yr. Flood (cfs)		SPF (cfs)	
		Ultimate	W/Project	Ultimate	W/Project
ML-1	Medicine Lake Outlet	168	245	520	530
MS-15	Winnetka Avenue (Ult.) Wisconsin Avenue (W/Proj.)	811	370	1,035	1,076
MS-14A	Hampshire Avenue (Ult.) Golden Valley Golf Course (W/Proj.)	918	420	1,797	1,135
MS-14B	Douglas Drive	908	435	1,868	1,135
MS-10	T.H. 100	1,331	955	4,084	3,280
MS-9A	Regent Avenue	1,082	855	4,110	2,422
MS-7D	Golden Valley Road	1,081	735	2,347	1,931
NB-2A	Louisiana Avenue	310	310	442	442
NB-2B	Florida Avenue (Ult.) Edgewood Control (W/Proj.)	280	300	292	676
NB-2C	34th Avenue	500	420	680	650
MS-4	T.H. 55	898	621	2,465	2,099
MS-2B	Cedar Lake Road	895	670	2,404	2,074
MS-1B	Conduit Storage Area	1,224	1,124	2,405	2,074
MS-1B	Conduit Entrance	820	659	1,033	934

Table A-4 Riprap Required

Feature Number	Location	Design Flood Frequency	Maximum Average Velocity (fps)	Turbulence Level	Required Minimum W50 (lbs) from HDC 712-1	Required Thickness (Inches)
	MAIN STEM					
5	Tunnel Inlet Channel	100-Year	2.25	Low	Less Than 10	12
5A	Upstream from Tunnel Inlet	100-Year	8.0	High	45	21
5	Ponding Area Inlet Drop Structure					
	Upstream from Drop Inlet	100-Year	7.5	Low	Less Than 10	12
	Downstream from Stilling Basin	100-Year	5.1	High	Less Than 10	12
8	Penn Avenue	100-Year	2.6	High	Less Than 10	12
9A	Fruen Mill Drop Structure					
	Upstream from Drop Inlet	100-Year	3.1	Low	Less Than 10	12
	Downstream from Stilling Basin	100-Year	4.8	High	Less Than 10	12
9B	RR Bridge	100-Year	4.2	High	Less Than 10	12
10	Highway 55 Control Structure					
	Upstream from Drop Inlet	100-Year	1.0	Low	Less Than 10	None
13	Noble Avenue Culvert					
	Upstream from Culvert Inlet	100-Year	5.5	Low	Less Than 10	12
	Downstream from Culvert Outlet	100-Year	5.5	High	Less Than 10	12
14	Regent Avenue Culvert					
	Upstream from Culvert Outlet	100-Year	5.2	Low	Less Than 10	12
	Downstream from Culvert Outlet	100-Year	5.2	High	Less Than 10	12
15A	Bridge Removal Minnagua Avenue					
	River Channel	100-Year	2.3	Low	Less Than 10	None
16	Highway 100 Control Structure					
	Downstream from Culvert Outlet	100-Year	5.9	High	Less Than 10	12
18	Culvert Replacement Westbrook					
	Upstream from Culvert Inlet	100-Year	5.1	Low	Less Than 10	12
	Downstream from Culvert Inlet	100-Year	5.1	High	Less Than 10	12

Table A-4 (Cont'd) Riprap Required

Feature Number	Location	Design Flood Frequency	Maximum Average Velocity (fps)	Turbulence Level	Required Minimum W50 (lbs) from HDC 712-1	Required Thickness (Inches)
19	Golden Valley Country Club Structure					
	Upstream from Culvert Inlet	100-Year	8.8	Low	11	12
	Downstream from Culvert Outlet	100-Year	8.8	High	84	33
20	Wisconsin Avenue Control Structure					
	Upstream from Inlet Control Structure	100-Year	7.7	Low	Less Than 10	12
	Downstream from Culvert Outlet	100-Year	7.7	High	36	24
21	Medicine Lake					
	Upstream from Control Weir	100-Year	2.5	Low	Less Than 10	None
	Downstream from Control Weir Through RR Bridge Outlet	100-Year	2.5	High	Less Than 10	12
	NORTH BRANCH					
23	Culvert Replacement 32rd Avenue					
	Upstream from Culvert Inlet	100-Year	4.4	High	Less Than 10	12
	Downstream from Culvert Outlet	100-Year	7.3	High	27	21
24	Culvert Replacement Brunswick Avenue					
	Upstream from Culvert Inlet	100-Year	4.4	Low	Less Than 10	12
	Downstream from Culvert Outlet	100-Year	4.4	High	Less Than 10	12
28	Culvert Replacement 34th Avenue					
	Upstream from Culvert Inlet	100-Year	10.7	Low	37	18
	Downstream from Culvert Outlet	100-Year	10.7	High	270	48
29	Culvert Replacement Douglas Drive					
	Upstream from Culvert Inlet	100-Year	4.2	Low	Less Than 10	12
	Downstream Culvert Outlet	100-Year	4.2	High	Less Than 10	12
31	Edgewood Control Structure					
	Upstream from Culvert Inlet	100-Year	8.7	Low	11	12
	Downstream from Culvert Outlet	100-Year	16.9	High	80*	30

*From USAEWES TMP H-72-5

Table A-4 (Cont'd) Riprap Required

Feature Number	Location	Design Flood Frequency	Maximum Average Velocity (fps)	Turbulence Level	Required Minimum W50 (lbs) from HDC 712-1	Required Thickness (inches)
33	Culvert Replacement Georgia Avenue					
	Upstream from Culvert Inlet	100-Year	6.4	Low	Less Than 10	12
	Downstream from Culvert Outlet	100-Year	6.4	High	13	18
34	Culvert Replacement 36th Street					
	Downstream from Culvert Outlet	100-Year	6.0	High	Less Than 11	12

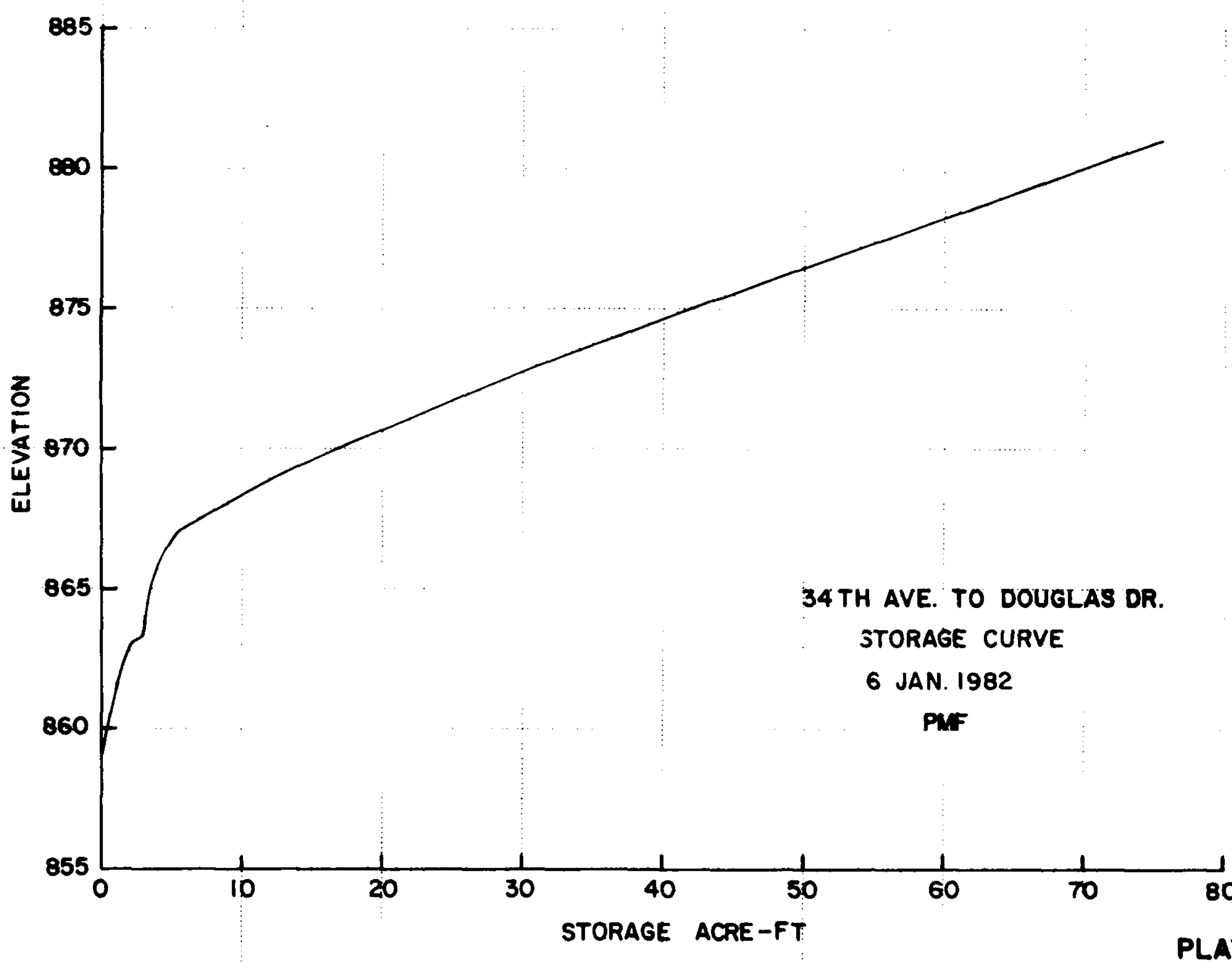

885
880
875
870
865
860
855
ELEVATION
0
10
20
30
40
50
60
70
80
STORAGE ACRE-FT
34TH AVE. TO DOUGLAS DR.
STORAGE CURVE
6 JAN. 1982
PMF

PLATE A-1

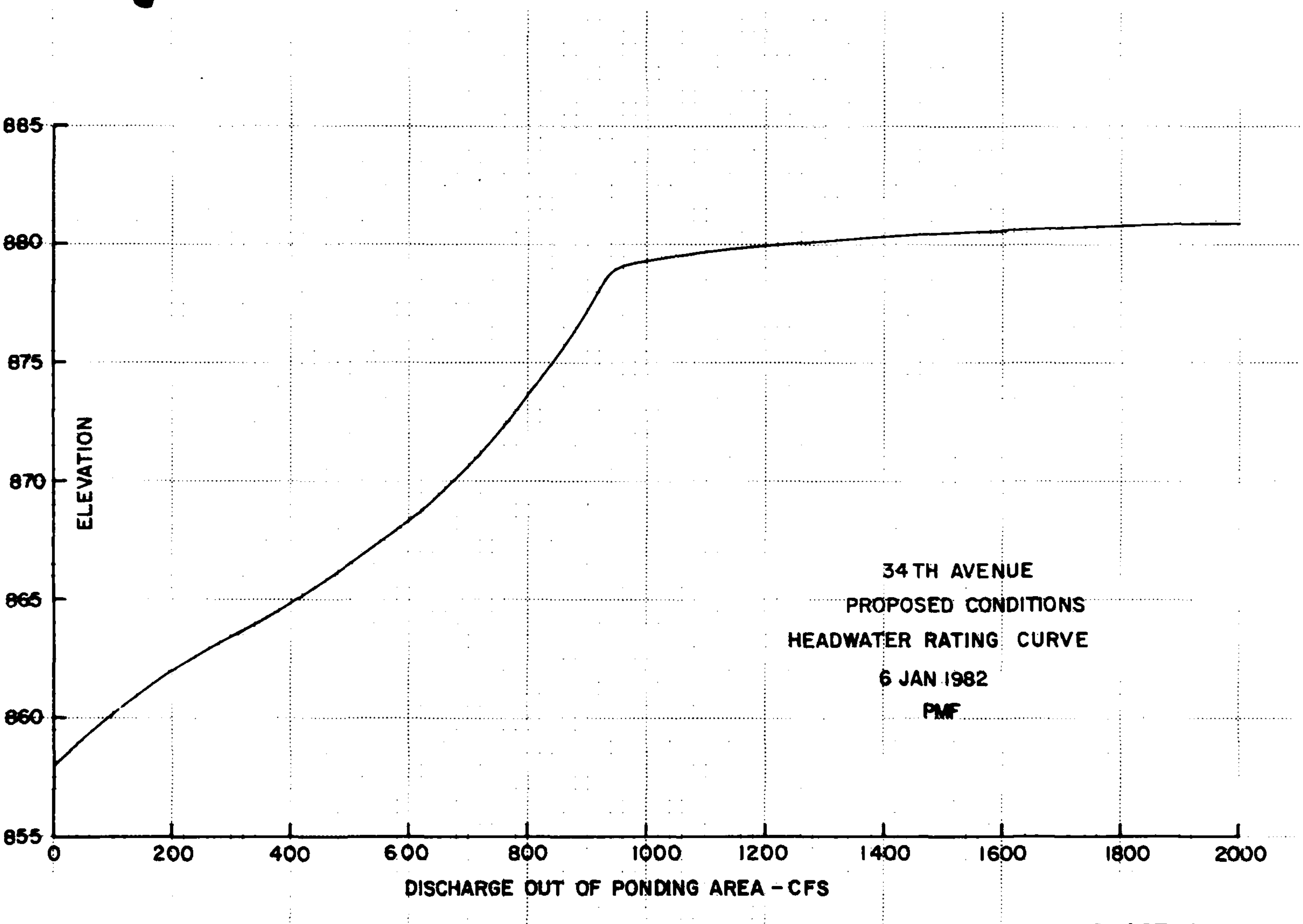

885
880
875
870
865
860
855
ELEVATION
0
200
400
600
800
1000
1200
1400
1600
1800
2000
DISCHARGE OUT OF PONDING AREA - CFS
34 TH AVENUE
PROPOSED CONDITIONS
HEADWATER RATING CURVE
6 JAN 1982
PMF

PLATE A-2

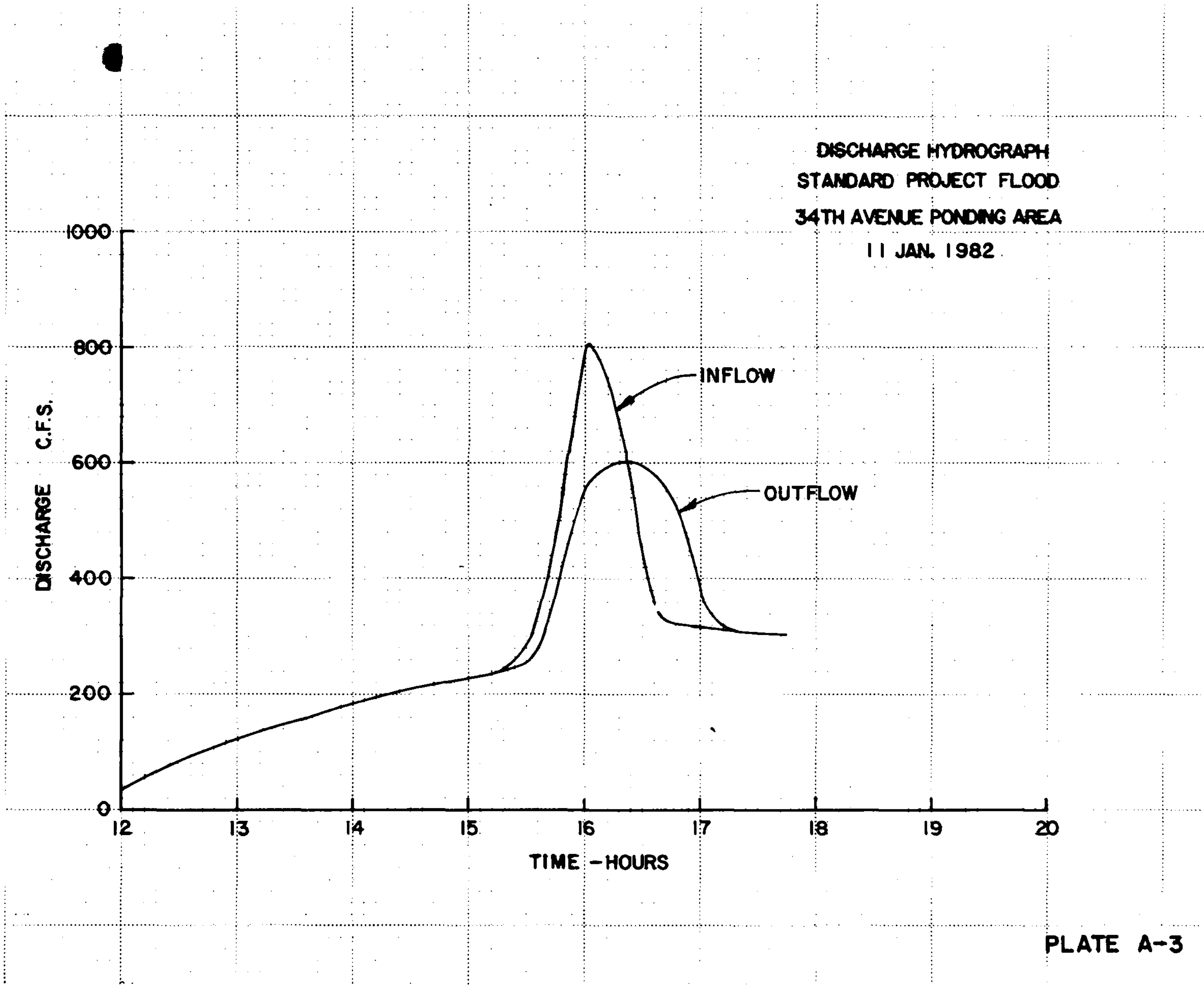
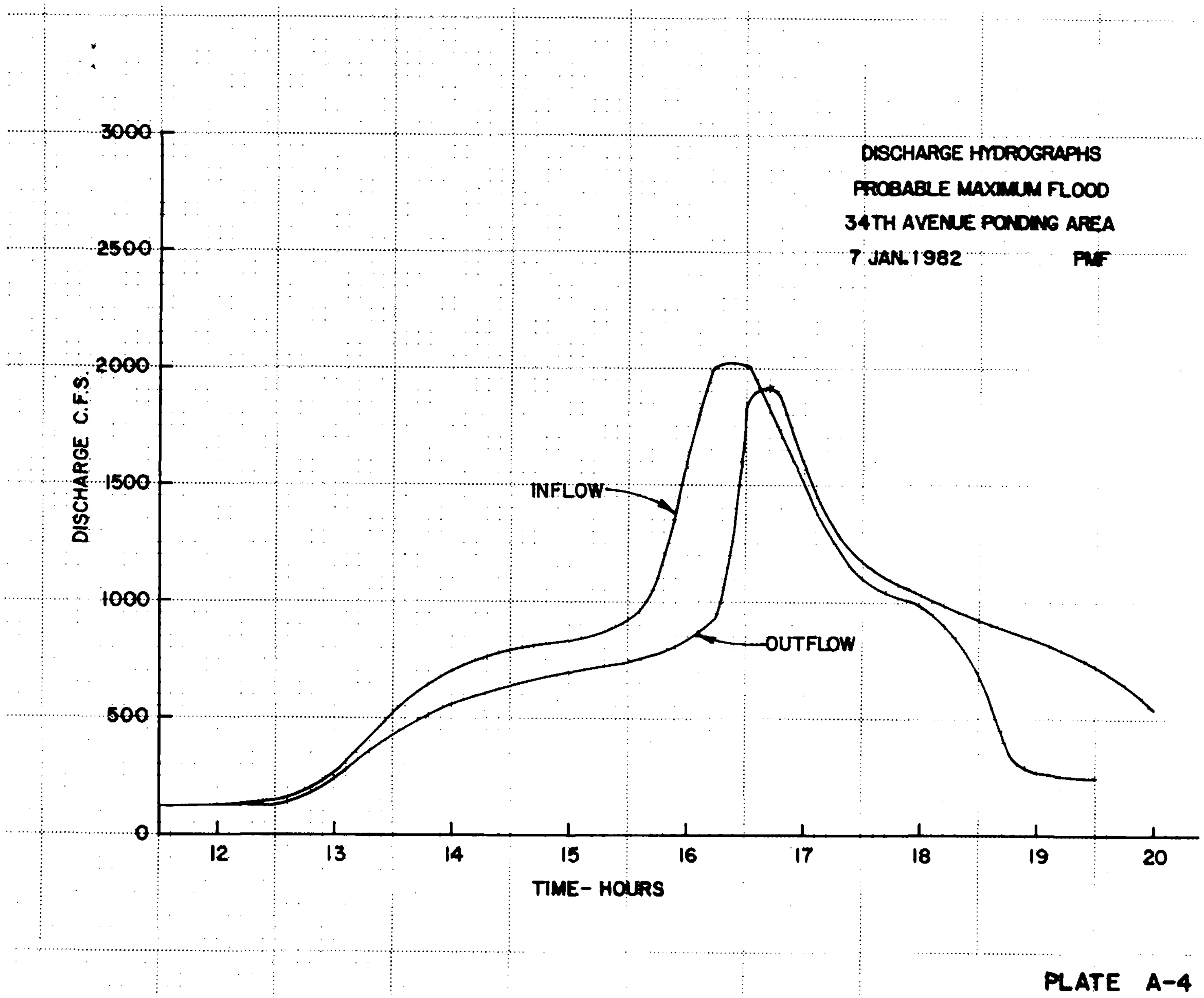
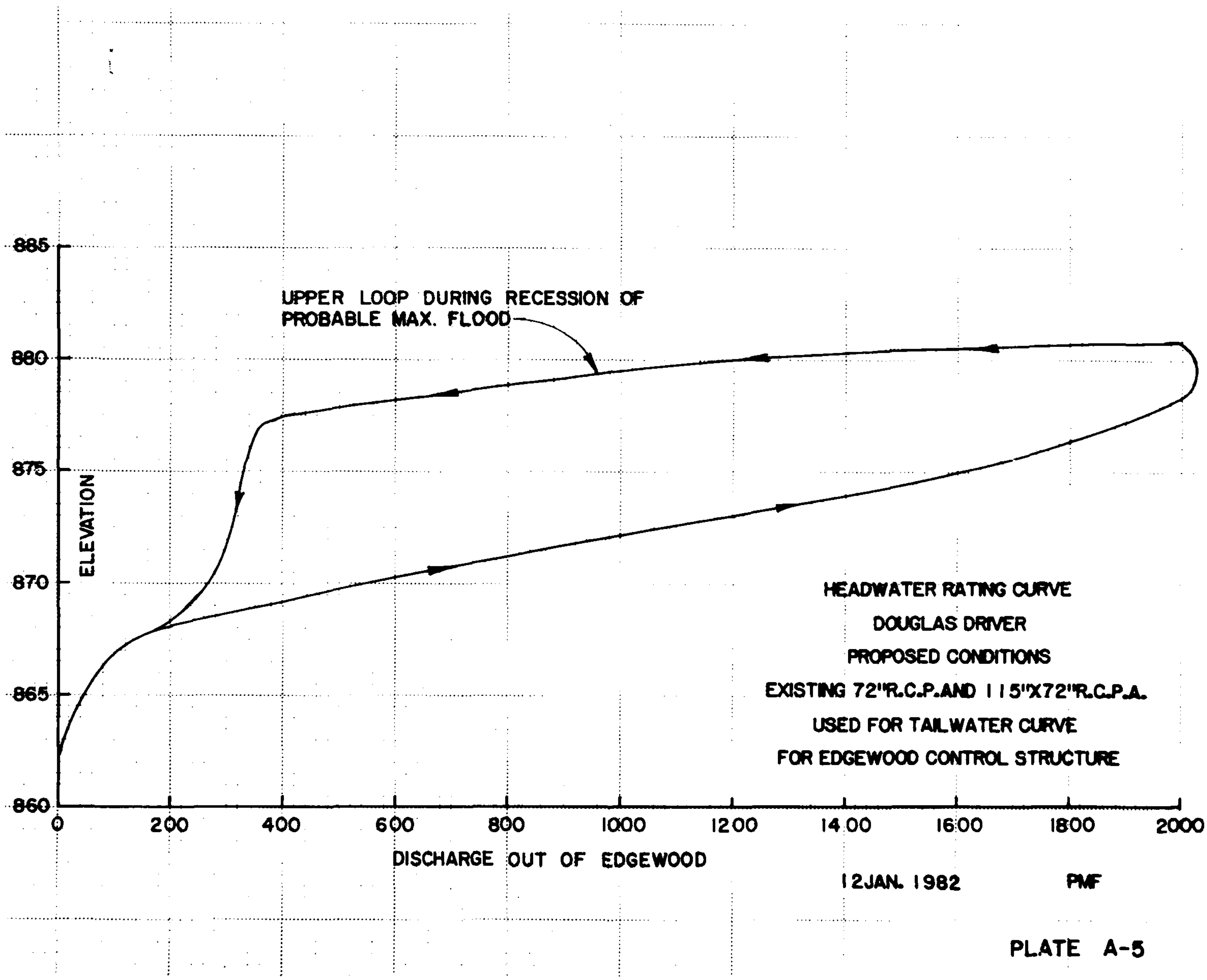

DISCHARGE HYDROGRAPH
STANDARD PROJECT FLOOD
34TH AVENUE PONDING AREA
11 JAN. 1982
INFLOW
OUTFLOW
DISCHARGE C.F.S.
1000
800
600
400
200
0
12
13
14
15
16
17
18
19
20
TIME - HOURS

PLATE A-3



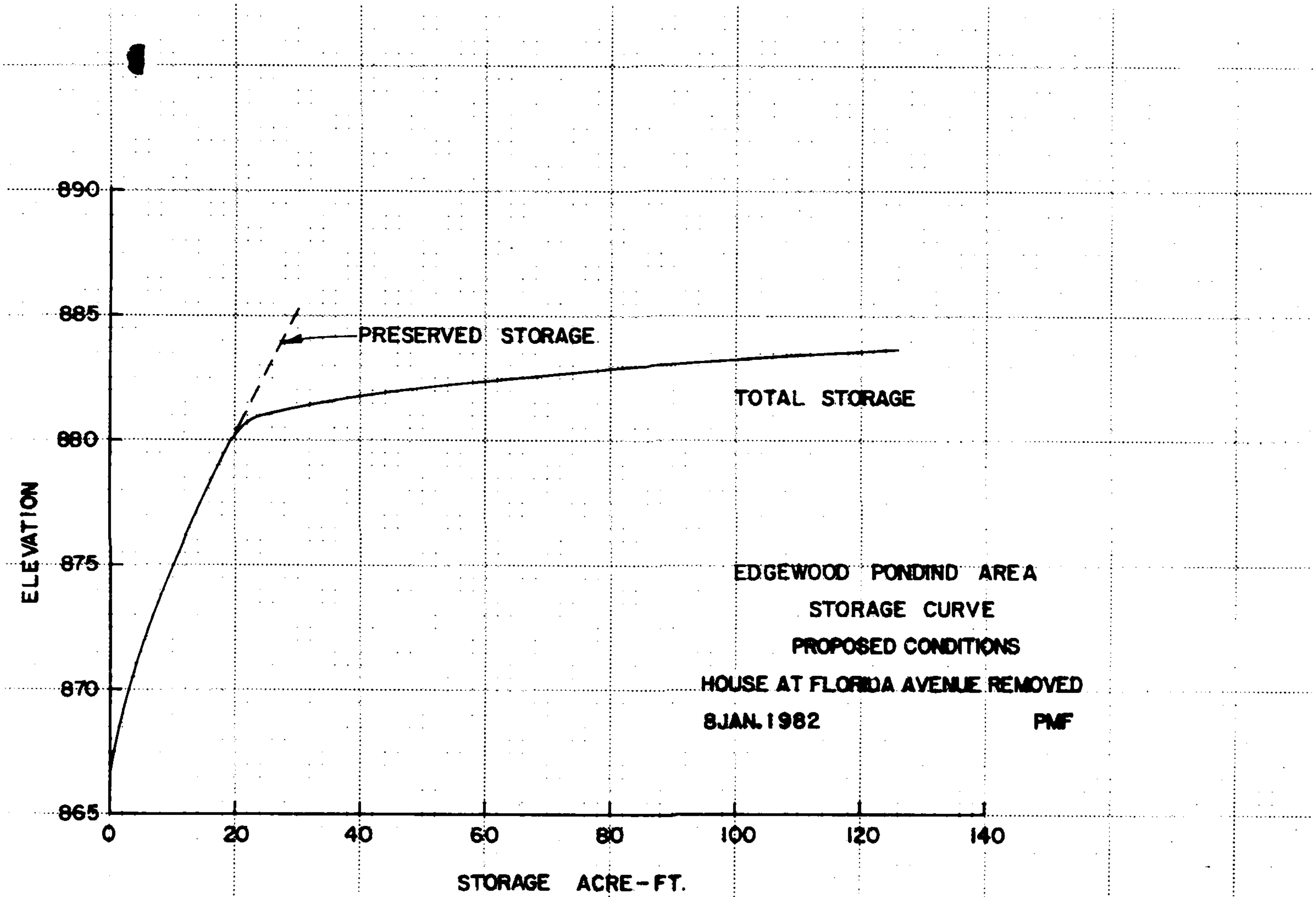
DISCHARGE HYDROGRAPHS
PROBABLE MAXIMUM FLOOD
34TH AVENUE PONDING AREA
7 JAN.1982
PMF
DISCHARGE C.F.S.
3000
2500
2000
1500
1000
500
0
INFLOW
OUTFLOW
12
13
14
15
16
17
18
19
20
TIME- HOURS

PLATE A-4



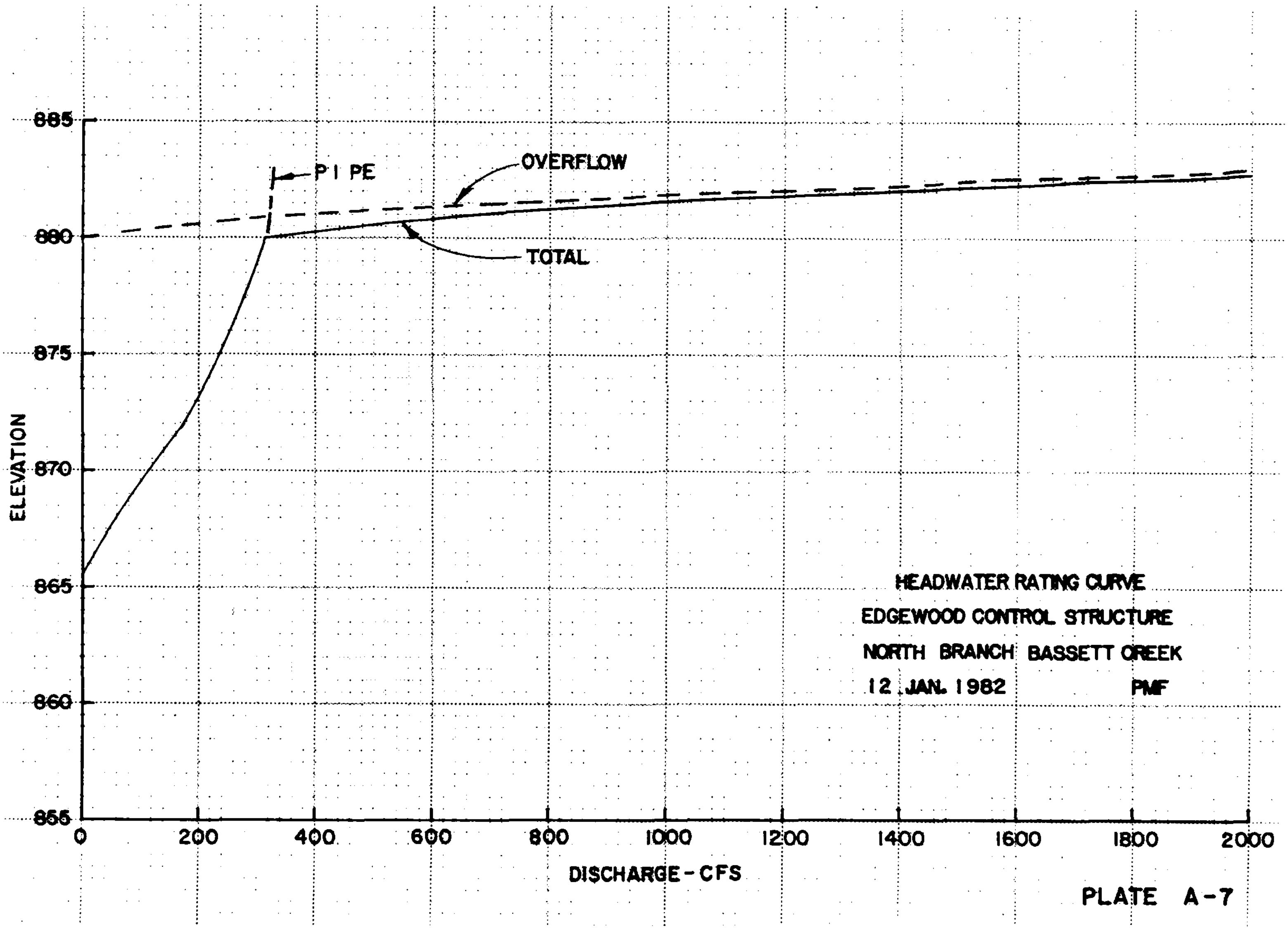
UPPER LOOP DURING RECESSION OF PROBABLE MAX. FLOOD
885
880
875
870
865
860
ELEVATION
0
200
400
600
800
1000
1200
1400
1600
1800
2000
DISCHARGE OUT OF EDGEWOOD
HEADWATER RATING CURVE
DOUGLAS DRIVER
PROPOSED CONDITIONS
EXISTING 72"R.C.P. AND 1 15"X72"R.C.P.A.
USED FOR TAILWATER CURVE
FOR EDGEWOOD CONTROL STRUCTURE
12 JAN. 1982
PMF

PLATE A-5



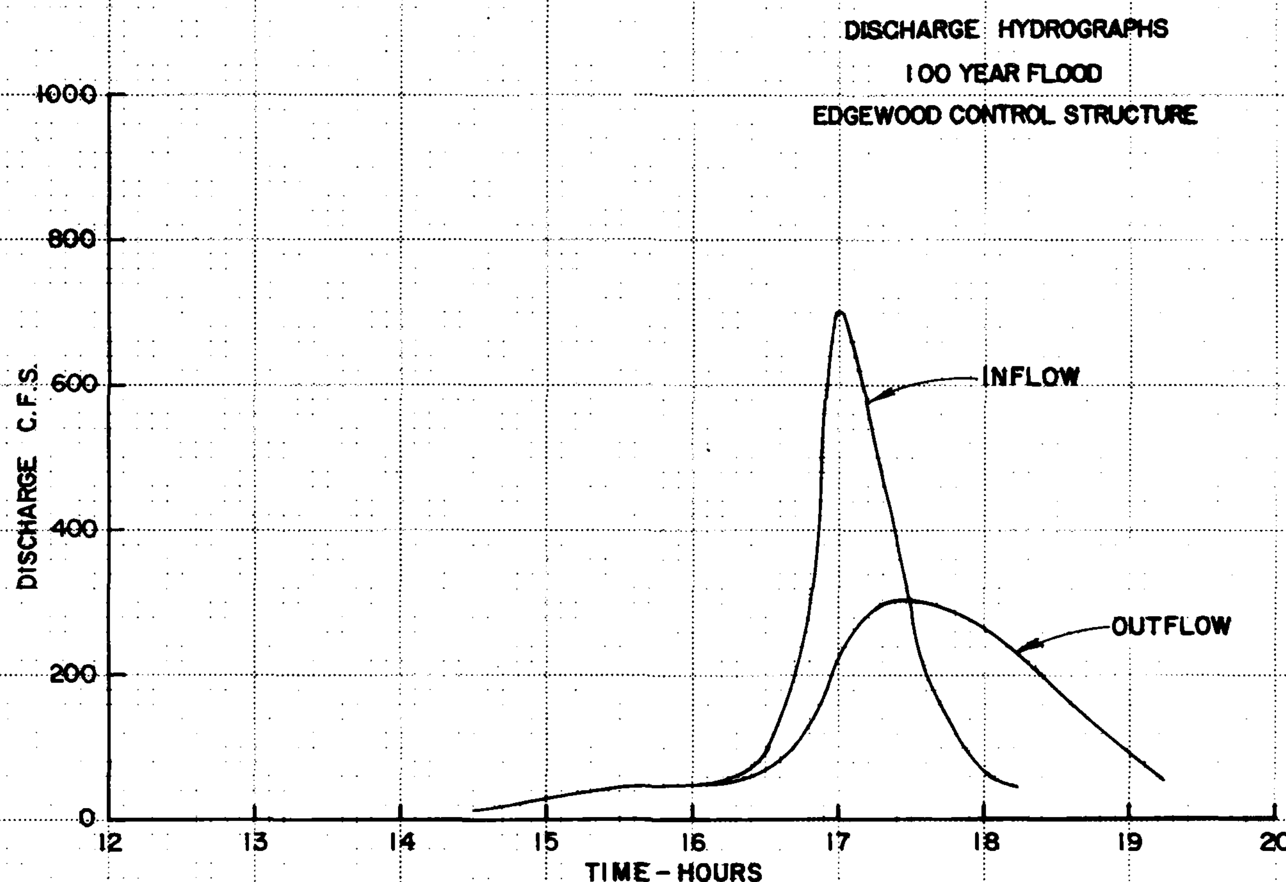
PRESERVED STORAGE
TOTAL STORAGE
ELEVATION
890
885
880
875
870
865
0
20
40
60
80
100
120
140
STORAGE ACRE-FT.
EDGEWOOD PONDIND AREA
STORAGE CURVE
PROPOSED CONDITIONS
HOUSE AT FLORIDA AVENUE REMOVED
8 JAN. 1982
PMF

PLATE A-6



885
880
875
870
865
860
855
ELEVATION
PIPE
OVERFLOW
TOTAL
0
200
400
600
800
1000
1200
1400
1600
1800
2000
DISCHARGE - CFS
HEADWATER RATING CURVE
EDGEWOOD CONTROL STRUCTURE
NORTH BRANCH BASSETT CREEK
12 JAN. 1982
PMF

PLATE A-7


DISCHARGE HYDROGRAPHS
100 YEAR FLOOD
EDGEWOOD CONTROL STRUCTURE
DISCHARGE C.F.S.
1000
800
600
400
200
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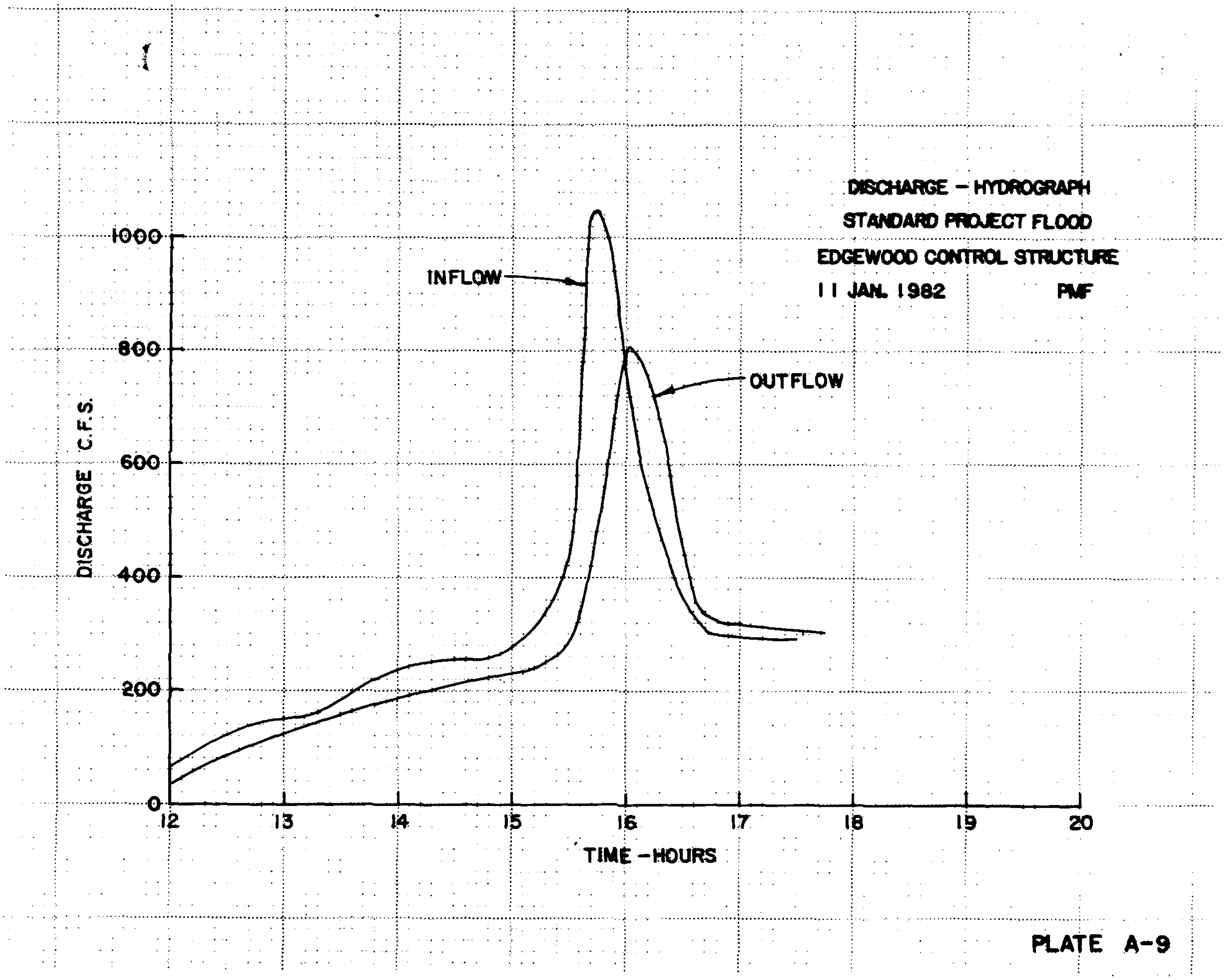
INFLOW
OUTFLOW
12
13
14
15
16
17
18
19
20
TIME - HOURS

PLATE A-8


DISCHARGE – HYDROGRAPH
STANDARD PROJECT FLOOD
EDGEWOOD CONTROL STRUCTURE
11 JAN. 1982
PMF
INFLOW
OUTFLOW
DISCHARGE C.F.S.
1000
800
600
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200
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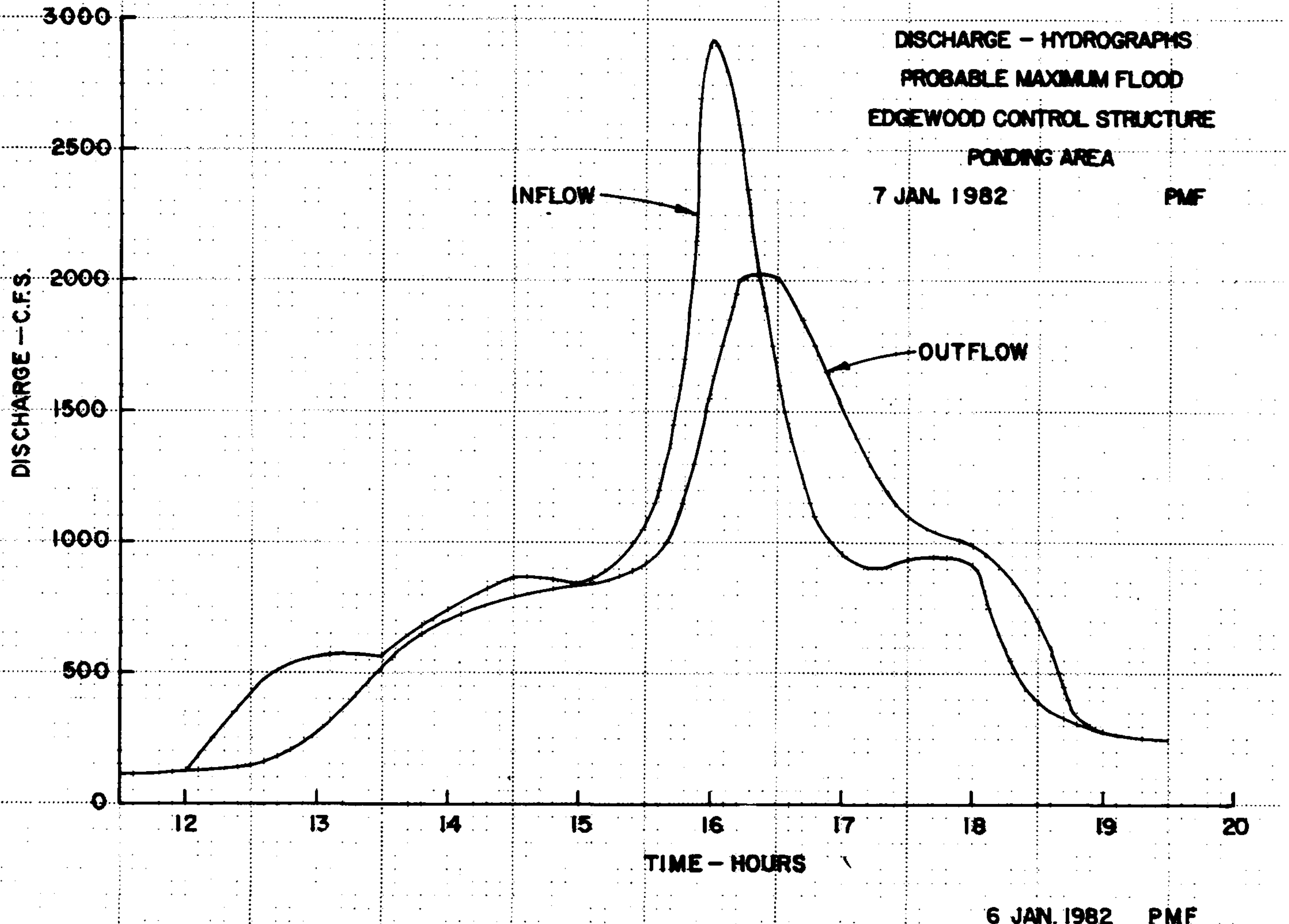
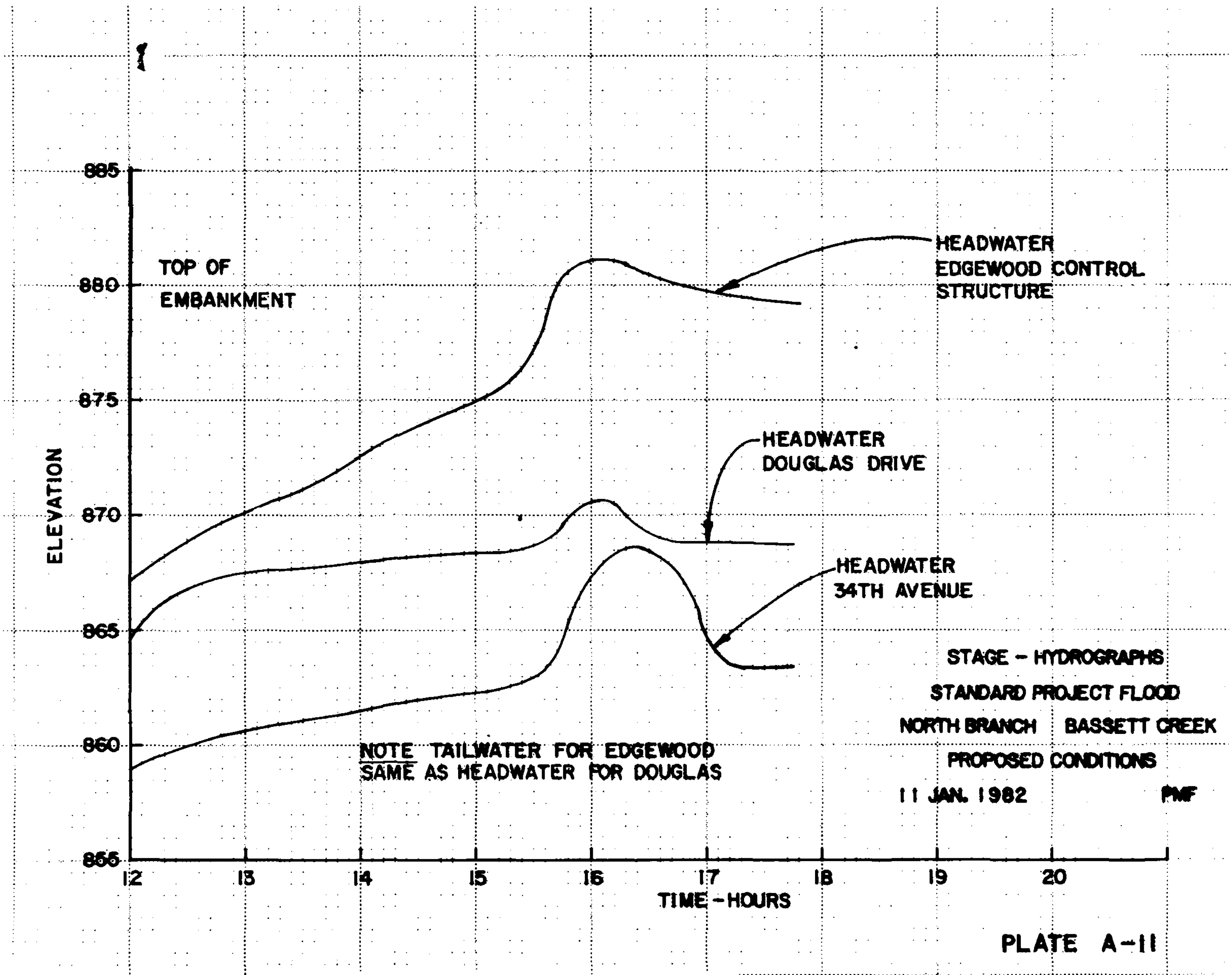
19
20
TIME – HOURS

PLATE A-9



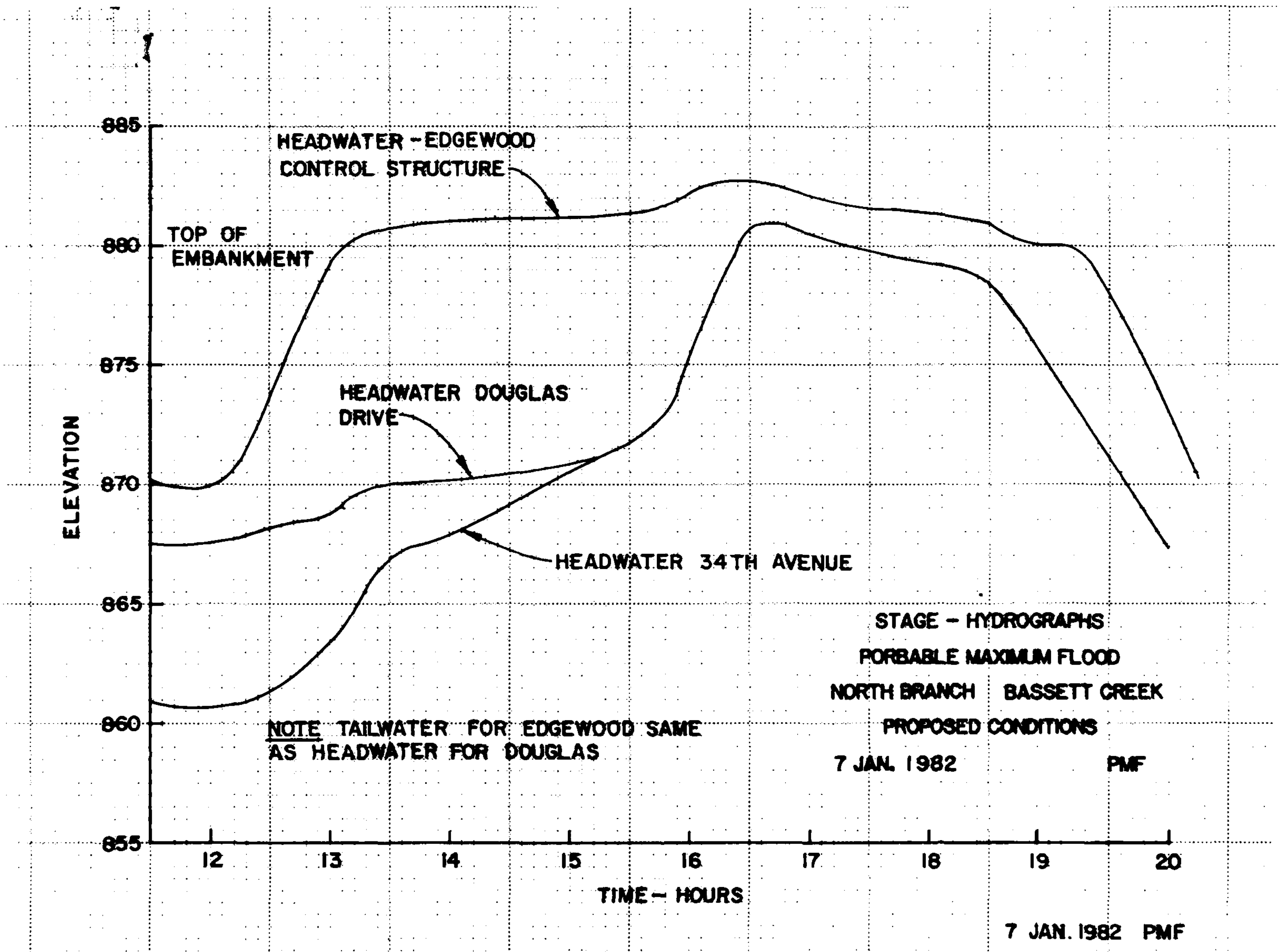
DISCHARGE - HYDROGRAPHS
PROBABLE MAXIMUM FLOOD
EDGEWOOD CONTROL STRUCTURE
PONDING AREA
7 JAN. 1982
PMF
INFLOW
OUTFLOW
DISCHARGE — C.F.S.
3000
2500
2000
1500
1000
500
0
12
13
14
15
16
17
18
19
20
TIME — HOURS
6 JAN. 1982 PMF

PLATE A-10



885
880
875
870
865
860
855
ELEVATION
TOP OF
EMBANKMENT
HEADWATER
EDGEWOOD CONTROL
STRUCTURE
HEADWATER
DOUGLAS DRIVE
HEADWATER
34TH AVENUE
NOTE TAILWATER FOR EDGEWOOD
SAME AS HEADWATER FOR DOUGLAS
STAGE - HYDROGRAPHS
STANDARD PROJECT FLOOD
NORTH BRANCH BASSETT CREEK
PROPOSED CONDITIONS
11 JAN. 1982
PMF
12
13
14
15
16
17
18
19
20
TIME - HOURS

PLATE A-11


HEADWATER - EDGEWOOD
CONTROL STRUCTURE
TOP OF
EMBANKMENT
HEADWATER DOUGLAS
DRIVE
HEADWATER 34TH AVENUE
NOTE TAILWATER FOR EDGEWOOD SAME
AS HEADWATER FOR DOUGLAS
ELEVATION
885
880
875
870
865
860
855
12
13
14
15
16
17
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19
20
TIME - HOURS
STAGE - HYDROGRAPHS
PORBABLE MAXIMUM FLOOD
NORTH BRANCH BASSETT CREEK
PROPOSED CONDITIONS
7 JAN. 1982 PMF
7 JAN. 1982 PMF

PLATE A-12

DEPARTMENT OF THE ARMY
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK WATERSHED

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX B

INTERIOR FLOOD CONTROL

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Table of Contents (Cont.)

Tables

Plates

Plates (Cont.)

APPENDIX B

INTERIOR FLOOD CONTROL

GENERAL

1. PROJECT PLAN

Interior flood control features are required for four areas of the Bassett Creek watershed. The four areas are referred to as the Western Avenue-Winnetka Avenue area (shown on Plate B-5), the Highway 100 North area (shown on Plate B-6), the Fruen Mill area below Glenwood Avenue (shown on Plate B-7) and the Bermed area by the conduit entrance (shown on Plate B-8). Flood control features for the low area northeast of the intersection of Western Avenue and Winnetka Avenue, as shown on Plate B-1, consist of a ponding area to elevation 886.1 and a flap-gated 24-inch CMP culvert under Winnetka Avenue and the proposed berm. Proposed features required north of the Highway 100 control structure, as shown on Plate B-2, include a ditch with 2-foot base width and 1 on 3 side slopes parallel to the levee, a 2-acre ponding area upstream and adjacent to the ditch, and a flap-gated 36-inch CMP culvert under Medicine Lake Road from the proposed interior ditch to the proposed ditch between the control structure and existing box culverts under Highway 100. The proposed interior flood control plan for the Fruen Mill area, as shown on Plates B-3 and B-7, consists of an excavated ponding area in the Glenwood-Inglewood parking lot and a flap-gated 36-inch RCP outlet at the southeast corner of the lot. Proposed features required for the Bermed area along the north side of the conduit entrance storage area, as shown on Plate B-4, include an excavated ponding area near Girard Avenue and the railroad tracks and a flap-gated 48-inch RCP culvert at the southwest corner of the ponding area.

2. CHANGES FROM DESIGN MEMORANDUM NO. 1

Since the completion of Design Memorandum No. 1, interior flood control features have been added for the Western Avenue-Winnetka Avenue area and the Bermed area along the north side of the conduit entrance storage area. These areas were added when it was found that water stored above the Wisconsin Avenue control structure and the conduit entrance could back up into each of these respective areas. Proposed features for the Highway 100 south area were eliminated when the control structure was moved about 150 feet upstream. Features for the Highway 100 North area were altered slightly because of this move. The interior flood control plan for the Fruen Mill area remains essentially the same as in Design Memorandum No. 1.

3. DESCRIPTION OF WATERSHEDS AND DRAINAGE PATTERNS

The Western Avenue-Winnetka Avenue watershed consists of about 83.6 acres of residential and undeveloped property as shown on Plate B-5. Most of the undeveloped area is very low and swampy. The area is generally bounded by Winnetka Avenue and high ground on the west and by high ground on the other sides. Runoff presently flows into the low area located in the middle of the watershed from all directions. Water ponded in the low area is eventually drained through a small CMP culvert of unknown size under Winnetka Avenue. Even after the proposed berm is constructed, runoff will continue to flow as it presently does, except that the ponded water will flow under Winnetka Avenue and the berm through the proposed 24-inch CMP culvert. In instances when Bassett Creek overtops its right bank and prevents outflow through the proposed culvert, runoff will pond in the low area until the creek recedes.

4. The area north of the Highway 100 control structure consists of about 23.6 acres of residential and undeveloped property as shown on Plate B-6. It is bounded by high ground to the north and west, Highway 100 to the east, and the proposed levee to the south and west. Runoff presently flows southwest into the creek. Once the proposed levee is constructed, runoff will temporarily pond in the low area along the levee, then flow along the proposed ditch and through the 36-inch CMP culvert into the ditch between the control structure and the existing box culverts under Highway 100.

5. The Fruen Mill watershed consists of about 6.3 acres of commercial property as shown on Plate B-7. It is bounded by Glenwood Avenue to the north, Bassett Creek to the west, and the Minneapolis Northfield and Southern Railroad tracks to the east. On the south side, the area will be bounded by a small proposed embankment and high ground. Runoff from the area presently flows to the south into the Glenwood-Inglewood parking lot and on into the creek. With construction of the proposed embankment, runoff will flow into the proposed ponding area in the Glenwood-Inglewood parking lot. From there it will discharge into Bassett Creek through the proposed 30-inch RCP outlet.

6. The watershed for the Bermed area northwest of the conduit entrance, as shown on Plate B-8, includes about 52.7 acres of residential and industrial property. It is bounded by high ground along Glenwood Avenue to the north, high ground to the east and west, and the proposed berm and high ground to the south. Under present conditions, runoff generally flows south into Bassett Creek and is aided by a RCP storm sewer system, consisting of pipe up to 21 inches in diameter, along 2nd Avenue North which discharges into the existing Bassett Creek tunnel. Once the proposed berm is constructed, runoff will flow into the proposed excavated ponding area near Girard Avenue and the railroad tracks. From there it will discharge into Bassett Creek through the proposed 48-inch RCP outlet.

7. PONDING AREAS

Elevation-area-storage curves for each of the four ponding areas are shown on Plates B-9 through B-12. Ponding will occur in the Western Avenue-Winnetka Avenue area at the low area northeast of the intersection, in the Highway 100 North area at the low area along the proposed levee, in the Fruen Mill area at the Glenwood-Inglewood parking lot, and in the Bermed area northwest of the conduit entrance at the excavated area near Girard Avenue and the railroad tracks.

8. DAMAGE-ELEVATION RELATIONSHIPS

Elevation-damage curves for the four areas are not available at this time. Approximate zero damage elevations are 887.3 in the Western Avenue-Winnetka Avenue area, 845.0 in the Highway 100 North area, 812.2 in the Fruen Mill area, and 805.1 in the Bermed area by the conduit entrance.

DESIGN CRITERIA

9. DEGREE OF PROTECTION

The Western Avenue-Winnetka Avenue area and the Highway 100 North area, are considered to be Class II urban development, as defined in EM 1110-2-1410 (reference 21a)*. The Fruen Mill area and Bermed area by the conduit entrance are considered to be Class I development. The design of features for the non-flood gravity discharge condition for Class II development is generally based on a 50-year rainfall frequency, while the design for Class I development is usually based on a 100-year rainfall frequency. However, since two of the four areas must be designed for the 100-year event and since the 100-year peak inflow rates for the other two areas are not substantially greater than the 50-year peak inflow rates, all areas were designed for the 100-year rainfall event. Protection against a standard project flood is not provided.

10. STREAMFLOW DATA

Discharge frequency curves for the main stem of Bassett Creek at Highway 100, at Highway 55 (just above the Fruen Mill area) and at the conduit entrance are shown on Plates 18, 21 and 22, respectively of Design Memorandum No. 1. Discharge rating curves for the main stem just below the Highway 100 control structure and below Glenwood Avenue are shown on Plates B-13 and B-14 while a headwater-discharge curve for the conduit entrance is shown on Plate B-15. Since streamflow records for the Bassett Creek watershed are incomplete, no stage-duration curves are provided.

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*This reference and all references which follow are described in paragraph 21.

11. RAINFALL DATA

The 24- and 96-hour duration rainfall depths for the 2-, 5-, 10-, 25-, 50- and 100-year all-year theoretical rainfall events for the study areas were obtained from U.S. Weather Bureau Reports Nos. 40 and 49, "Rainfall Frequency Atlas of the United States" (references 21b and 21c). These point rainfall depths are shown in Table B-1 along with the 1-year point rainfall depth which was obtained from the exceedence frequency versus point rainfall depths plot shown on Plate B-16. Also shown in Table B-1 are standard project storm values for the 24- and 96-hour durations which were developed in accordance with criteria presented in EM 1110-2-1411 (reference 21d). Because of the small size of the Bassett Creek watershed, rainfall is assumed to occur simultaneously over the entire watershed. Based on this assumption, interior watershed runoff and streamflow runoff are dependent on one another.

12. RAINFALL EXCESS AND RUNOFF HYDROGRAPHS

Key parameters used in development of the runoff hydrographs are shown in Table B-2. Surface cover, slopes and flow lengths were obtained from aerial photos and USGS quad sheets. Flow velocities in each area were obtained using Figure 3-1 in Soil Conservation Service Technical Release (TR) No. 55 (reference 21g). Times of concentration (Tc) were calculated by dividing the overland flow length by the velocity. A SCS unit hydrograph corresponding to the Tc for each area was obtained from Table 5-3 of TR-55 (reference 21g). Runoff curve numbers (CN) for each area were obtained from Table 2-2 of TR-55 and used to obtain the runoff hydrographs. Rainfall excess (Q) was calculated using the following formula:

$$Q = \frac{(P - 0.2\ S)^2}{P + 0.8\ S}$$

in which P is the 24-hour precipitation and $S = \frac{1000}{CN} - 10$. Runoff hydrographs were developed by multiplying the SCS unit hydrograph by Q and the drainage area in square miles. The resulting runoff hydrographs are presented in Tables B-3, B-4 and B-5. Runoff hydrographs were not developed for the Western Avenue-Winnetka Avenue area as the ponding area has enough storage capacity to pond the 96-hour duration standard project storm, assuming 70 percent runoff. The 24-inch CMP culvert under Winnetka Avenue will serve to empty the pond once Bassett Creek recedes. The runoff hydrographs for the Bermed area by the conduit entrance were reduced by the capacity of the existing storm sewer, about 33 cfs, which outlets into the existing Bassett Creek tunnel.

13. SEEPAGE

Due to the short duration of flood conditions, seepage was considered to be negligible.

DESIGN OF INTERIOR FLOOD CONTROL FEATURES

14. GENERAL

Each time there is a significant amount of rainfall runoff from each of the protected areas there is also a simultaneous rise in the level of Bassett Creek. Because of this condition, the design of the required gravity flow and blocked gravity flow interior flood control features was performed simultaneously. The location of the proposed interior flood control features are shown on Plates B-1, -2, -3 and -4 and defined in paragraph 1 and in Tables B-6 and B-7. The proposed drainage plan is described in paragraphs 3 through 6. One-percent and standard project storm interior pond levels for both existing and proposed conditions are shown in Table B-9.

15. DESIGN OF OUTLETS AND DITCHES

The hydraulic design of the outlets is based on procedures outlined in TM 5-820-4 (reference 21e) and on the inflow from the 100-year frequency rainfall event. Design data for each outlet are presented in Table B-6. Manning's roughness coefficient "n" is assumed to be 0.014 for RCP and 0.024 for CMP, and the entrance loss coefficient "Ke" is assumed to be 0.5. Pipe sizes were selected to maintain design water surface elevations below the zero damage elevation during a 100-year rainfall event. A discharge rating curve for each of the four outlets is shown on Plates B-17 through B-20. All outlets will be furnished with safety guards to improve safety and reduce debris deposition in pipes. All gravity outlets will be equippped with flap-gates.

16. The design of the one drainage ditch is also based on criteria presented in TM 5-820-4 (reference 21e) and on the peak 100-year outflow through the proposed Highway 100 North outlet. Design data for the ditch are presented in Table B-7. The ditch will be grass-lined with 1 on 3 side slopes. Manning's roughness coefficient "n" is assumed to be 0.040.

17. MAXIMUM POND LEVELS

The maximum interior pond levels shown in Table B-8, for all areas, except the Western Avenue-Winnetka Avenue area, were obtained by routing the runoff hydrographs for each area through the proposed ponding areas and outlets and assuming no outflow after the Bassett Creek stage equalled

the interior pond elevation. Runoff hydrographs for Bassett Creek are only available for the 100-year event and the standard project storm. However, since the standard project storm (SPS) overtops the levee or berm in all three areas, the check for when the Bassett Creek stage equalled the interior pond elevation was done for the 100-year event only. Routing the 100-year storm through each of the three areas resulted in two peak ponding levels. First based on gravity flow conditions and second based on blocked gravity conditions. (During a 100-year storm over the entire basin, it is estimated that almost all the interior runoff will discharge into the creek before the river rises to the level required for blocked gravity conditions.) In all three areas, the maximum elevation obtained during gravity flow condition was considerably higher than the elevation reached by ponding all inflow after the river stage equalled the interior pond elevation. As this was true for the 100-year event, it was assumed to hold true for the lower frequency storms also. Therefore, the elevations in Table B-8 for the Highway 100 North area, the Fruen Mill area and the Bermed area by the conduit entrance are the maximum gravity flow elevations. Since there is excess storage available in the Western Avenue-Winnetka Avenue ponding area, the pond levels in Table B-8 are for ponding the 96-hour duration storm assuming 70 percent runoff. (This area is currently owned and maintained by the city of Golden Valley as a wetland area with no future changes in land uses anticipated.) Since rainfall and river stage are dependent events for the Bassett Creek watershed, the probability of a given river stage is assumed to be equivalent to the probability of the rainfall event which produced it. The frequencies assigned to the maximum interior pond elevations in Table B-8 are based on this assumption. A fence is recommended around the excavated ponding area for the Bermed area by the conduit entrance as water will be ponded more than 4 feet deep.

18. ONE-PERCENT AND SPS POND LEVELS

One-percent (100-year) and standard project storm pond levels are presented in Table B-9. The standard project storm pond levels shown are the SPF elevation for Bassett Creek obtained from the HEC-2 backwater computations. In all four areas, the proposed levee or berm will be overtopped by the SPF on Bassett Creek. No flood damages are expected during the 100-year event, while considerable damages are expected during the SPF.

19. JUSTIFICATION

Based on the dependent rainfall analysis performed, the recommended interior flood control plan appears to be the most economical and will keep the 100-year pond level below the apparent zero damage elevation. Pumping stations are not necessary as the majority, if not all, of the interior runoff will pass through the outlets before the creek rises enough to close the flap-gates.

20. OTHER ALTERNATIVES CONSIDERED

In addition to the recommended design, various outlet sizes and alternate ponding conditions were considered for each of the four areas. Each of these alternatives, however, were found to be more costly than the recommended plan. For the Bermed area by the conduit entrance, a larger outlet which would eliminate the need for a ponding area was considered, but not recommended because a larger outlet would require a gatewell with sluice gate in addition to the flap-gate, and therefore result in a more costly plan. Also, the use of large flap-gates is very unreliable.

21. REFERENCES

a. EM 1110-2-1410, Interior Drainage of Leveed Urban Areas; Hydrology.

b. National Weather Service Technical Report No. 40, "Rainfall Frequency Atlas of the United States," May 1961.

c. National Weather Service Technical Report No. 49, "Two - To Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States," 1964.

d. EM 1110-2-1411, Standard Project Flood Determinations (Civil Works Engineer Bulletin No. 52-8, March 1952).

e. TM 5-820-4, Drainage for Areas other than Airfields. (EM 1110-345-284)

f. EM 1110-2-1601, "Hydraulic Design of Flood Control Channels."

g. Soil Conservation Service Technical Release No. 55, "Urban Hydrology for Small Watersheds."

TABLE B-1

BASSETT CREEK WATERSHED

POINT RAINFALL VALUES IN INCHES

	DURATION	
Return Period	24-hour	46-hour
1-year	2.17	3.17
2-year	2.75	4.00
5-year	3.52	5.00
10-year	4.14	5.71
25-year	4.75	6.72
50-year	5.28	7.51
100-year	5.92	8.30
SPS*	11.2	13.6

*SPS estimates are for the entire Bassett Creek Watershed rather than point rainfall values.

TABLE B-2

INTERIOR WATERSHED PARAMETERS

Section	Area Mi^2	Area Acres	Slope Ft/Ft	Velocity Ft/Sec	Overland Flow Length Ft.	T_c Hours	SCS Curve Number CN (1)
Highway 100 North	0.037	23.6	0.025	0.9	2,000	0.62	87
Fruen Mill Area	0.010	6.3	0.035	2.5	800	0.10	89
Bermed Area by conduit entrance	0.082	52.7	0.042	1.4	500(2)	0.88	92
			0.005	0.5	1,400		

(1) Antecedent moisture condition III
(2) The overland flow length was divided into two parts because of the change in slope and cover type.

TABLE B-3

RUNOFF HYDROGRAPHS
HIGHWAY 100 NORTH

RAINFALL EVENT IN YEARS

Time in Hours	1	2	5	10	25	50	100	SPS
10.0	0	0	0	0	0	0	0	0
10.5	0	1	1	1	1	1	1	3
11.0	1	1	1	2	2	2	3	6
11.5	1	2	3	3	4	5	5	12
12.0	16	23	34	43	51	59	68	148
12.5	12	18	25	32	38	44	51	111
13.0	5	7	10	12	14	17	19	42
13.5	3	4	5	7	8	9	11	23
14.0	2	3	4	5	6	7	8	17
14.5	1	2	3	4	5	5	6	13
15.0	1	2	3	3	4	5	5	11
15.5	1	2	2	3	3	4	4	10
16.0	1	1	2	2	3	3	4	8
16.5	1	1	1	2	2	3	3	6
17.0	1	1	1	2	2	2	2	5
17.5	0	1	1	1	1	2	2	4
18.0		1	1	1	1	1	2	4
18.5		1	1	1	1	1	1	3
19.0		0	1	1	1	1	1	3
19.5			1	1	1	1	1	2
20.0			0	1	1	1	1	2
20.5				1	1	1	1	2
21.0				0	0	1	1	1
21.5						0	0	1
22.0								1
22.5								0

TABLE B-4

RUNOFF HYDROGRAPHS
FRUEN MILL AREA BELOW GLENWOOD AVENUE

Time in Hours	RAINFALL EVENT IN YEARS 1	2	5	10	25	50	100	SPS
10.0	0	0	0	0	0	0	0	0
10.5	0	0	0	0	0	0	1	1
11.0	0	0	1	1	1	1	1	2
11.5	1	1	1	2	2	2	2	5
12.0	12	17	24	29	35	40	46	98
12.5	1	2	3	3	4	4	5	11
13.0	1	1	2	2	2	3	3	6
13.5	1	1	1	1	2	2	2	5
14.0	0	1	1	1	1	2	2	4
14.5		1	1	1	1	1	2	3
15.0		0	1	1	1	1	1	3
15.5			1	1	1	1	1	2
16.0			0	1	1	1	1	2
16.5				1	1	1	1	2
17.0				0	0	1	1	1
17.5						0	1	1
18.0							0	1
18.5								1
19.0								1
19.5								1
20.0								0

TABLE B-5

RUNOFF HYDROGRAPHS*
BERMED AREA BY CONDUIT ENTRANCE

Time In Hours	RAINFALL EVENT IN YEARS 1	2	5	10	25	50	100	SPS
11.0	0	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	0	0
12.0	0	5	19	31	42	53	65	167
12.5	7	22	43	61	78	93	111	261
13.0	0	0	3	11	19	26	35	106
13.5			0	0	0	0	4	42
14.0							0	16
14.5								3
15.0								0

*Runoff hydrographs minus the capacity of the existing storm system, about 33 cfs, which outlets into the existing Bassett Creek tunnel.

TABLE B-6

DESIGN OF GRAVITY OUTLETS

Outlet Location	Western Avenue-Winnetka Avenue Area	Highway 100 North	Fruen Mill Area	Bermed Area by Conduit Entrance
Pipe Diameter, In.	24	36	30	48
No. of Pipes Required	1	1	1	1
Type	CMP	CMP	RCP	RCP
Design Discharge, cfs	21	44	23	90
Slope, Ft/Ft	0.0156	0.008	0.0025	0.0031
Upstream Invert Elevation	882.0	840.0	809.2	800.0
Approximate Length, Ft.	90	125	80	320
Maximum Design Water Surface Elevation	886.1	844.3	811.9	805.1
Zero Damage Elevation	887.3	845.0	812.2	805.1

TABLE B-7

DRAINAGE DITCH DATA

Location	Highway 100 North Ponding Area
100-Year Discharge, cfs	44
Channel Length, Ft.	500
Channel Slope, Ft./Ft.	0.006
Channel Invert Elevation, Upstream	843.0
Channel Invert Elevation, Downstream	840.0
Side Slopes	1 on 3
Manning's "n"	0.040
Water Depth at Design Flow, Ft.	1.9
Bottom Width, Ft.	2
Velocity at Design Q, Ft/Sec	3.0

TABLE B-8

INTERIOR POND LEVELS

ALL-YEAR RAINFALL FREQUENCY

1-Year	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Western Avenue-Winnetka Avenue Area						
884.7	884.9	885.2	885.4	885.7	885.9	886.1
Highway 100 North						
841.9	842.3	843.0	843.4	843.8	844.1	844.3
Fruen Mill Area						
810.1	810.5	810.9	811.1	811.4	811.6	811.9
Bermed Area by Conduit Entrance						
800.6	801.5	802.5	803.2	803.8	804.5	805.1

TABLE B-9

ONE-PERCENT AND STANDARD PROJECT STORM
INTERIOR POND LEVEL DATA

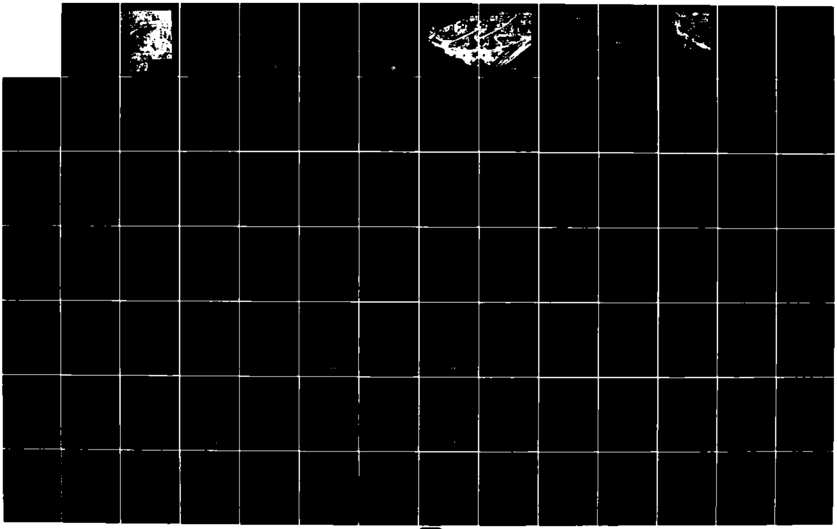
Rainfall Event	EXISTING CONDITIONS One-Percent (100-year)	EXISTING CONDITIONS SPS	PROPOSED CONDITIONS One-Percent (100-year)	PROPOSED CONDITIONS SPS
Western Avenue-Winnetka Avenue Area	888.1	890.4	886.1	890.6
Highway 100 North Area	847.2	852.5	844.3	853.5
Fruen Mill Area	816.1	823.0	811.9	822.8
Bermed Area by Conduit Entrance	812.3	822.2	805.1	822.2

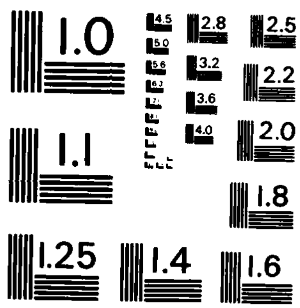

PROPOSED
BERM
100
0
SCALE

AD-A133 795   BASSETT CREEK WATERSHED HENNEPIN COUNTY MINNESOTA
FEASIBILITY REPORT FOR FLOOD CONTROL MAIN REPORT(U)
CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 82

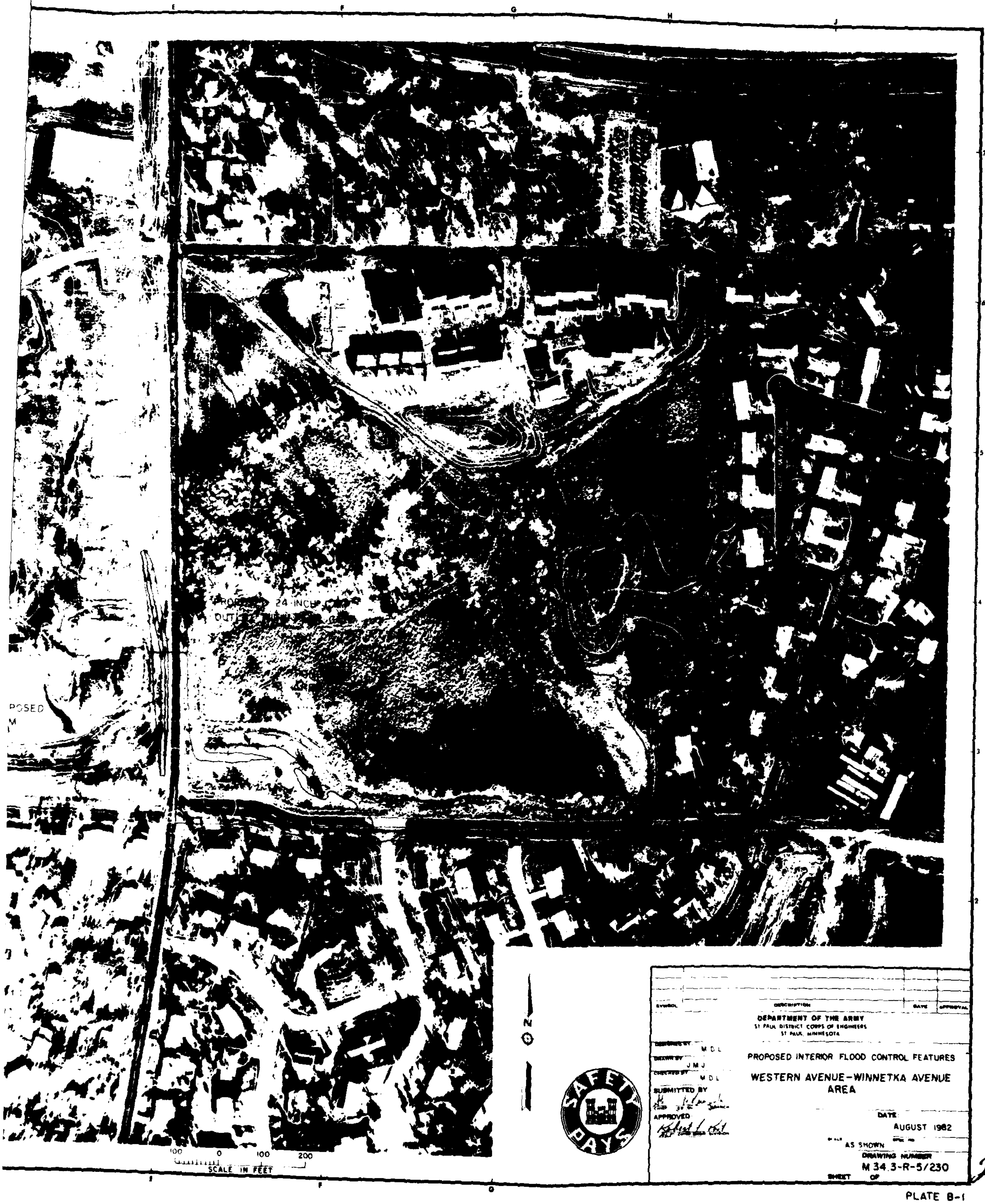
3/7

UNCLASSIFIED   F/G 13/2   NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY M D L
DRAWN BY J M J
CHECKED BY M D L
SUBMITTED BY
APPROVED

PROPOSED INTERIOR FLOOD CONTROL FEATURES

WESTERN AVENUE–WINNETKA AVENUE AREA

DATE: AUGUST 1982

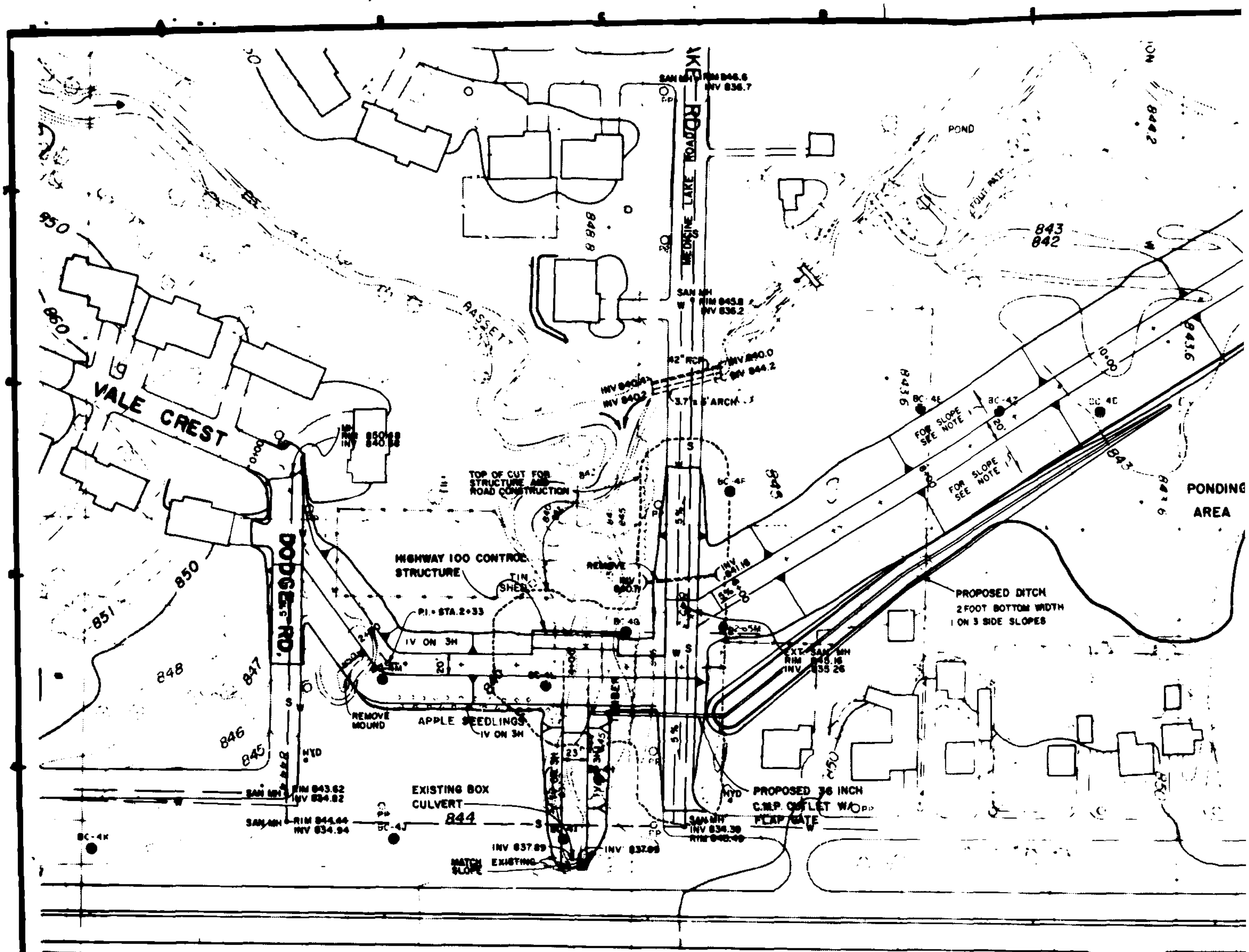
SCALE: AS SHOWN

DRAWING NUMBER: M 34.3-R-5/230

SHEET OF

2

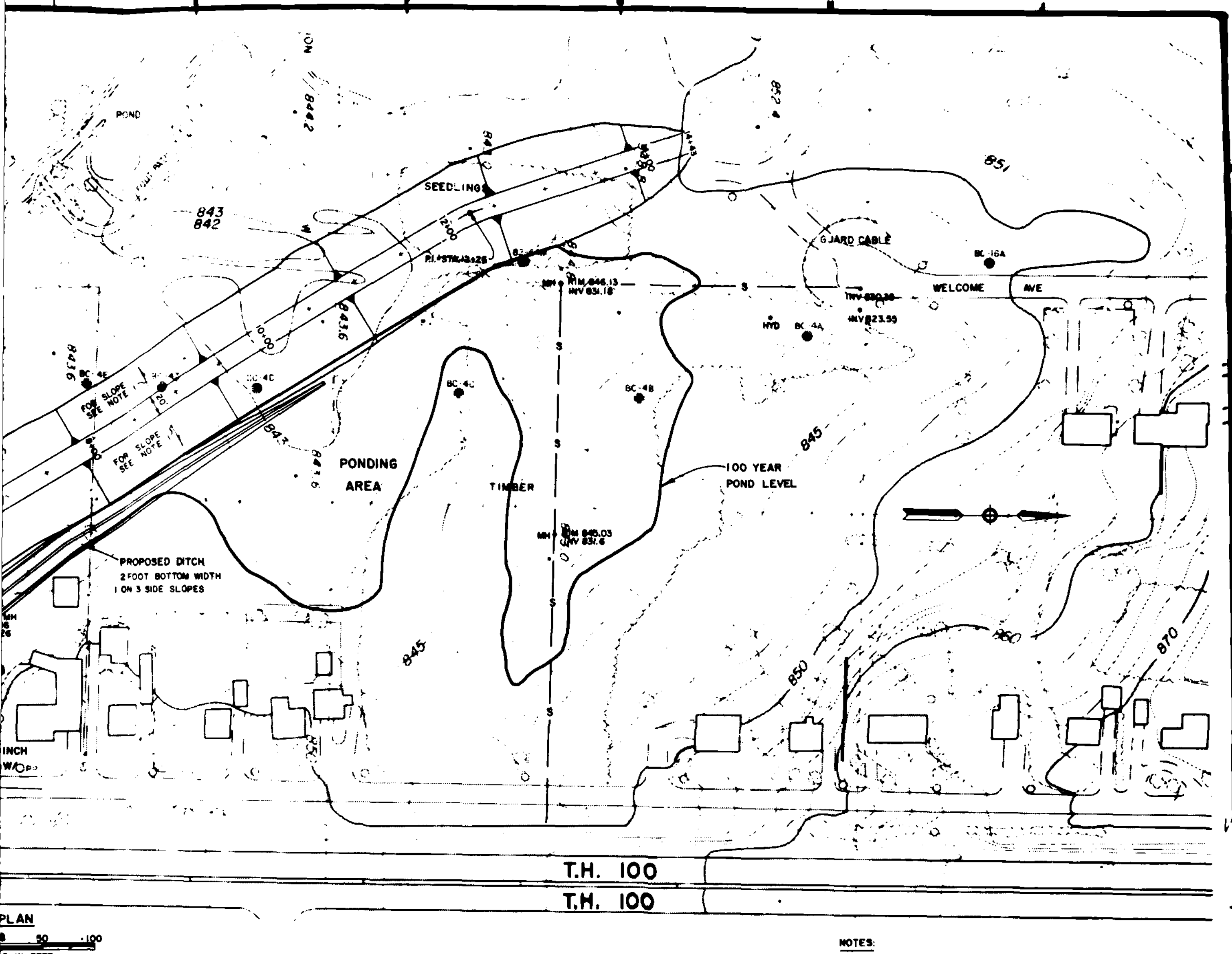
PLATE B-1



PLAN

50 0 50 100

SCALE IN FEET



NOTES:

1. Due to large amounts of settlement upstream slope will change from 1 V on 3 H at End to Construction to 1 V on 4.75 H after 100 years of secondary consolidation. likewise the downstream slop will vary from 1 V on 3.7 H to 1 V on 6 H.
2. The embankment from Sta. 6+00 to 14+00 will be constructed in three stages over a two year period. (See Plate)

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

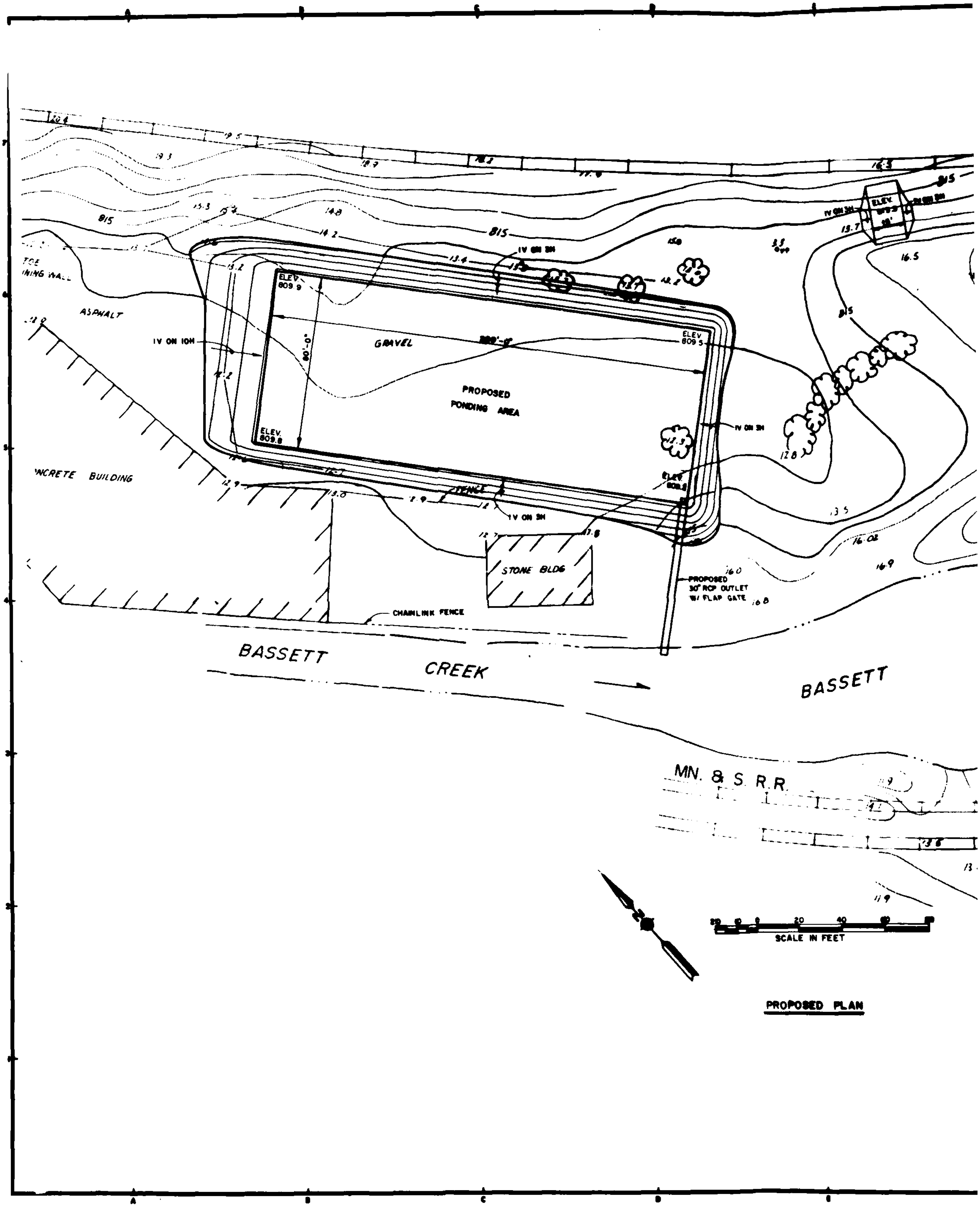
D.W.R. & M.D.L.
W.J.V.
M.C.B.

PROPOSED INTERIOR FLOOD CONTROL FEATURES
HIGHWAY 100 NORTH

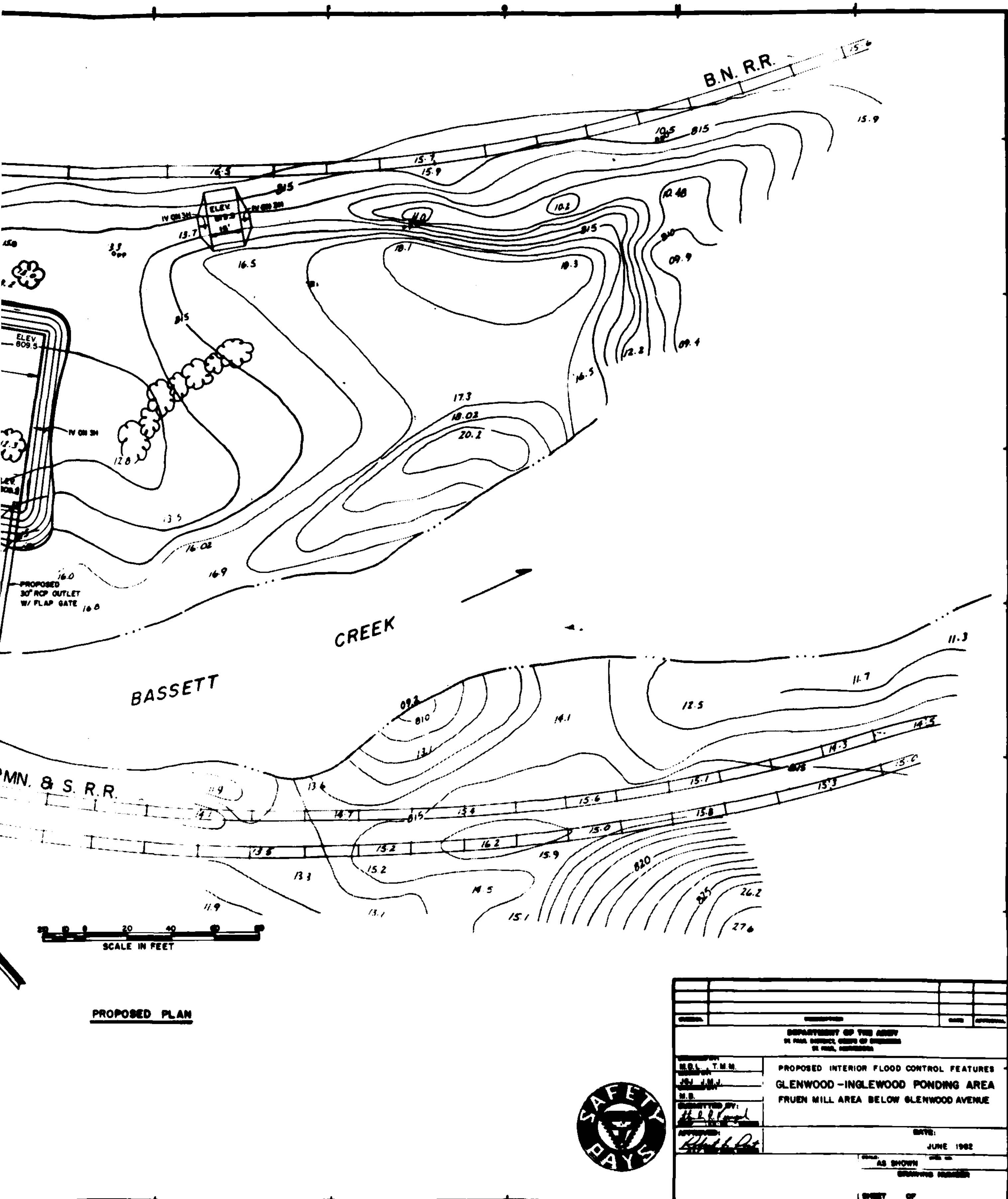
JUNE 1982

AS SHOWN

PLATE B-2



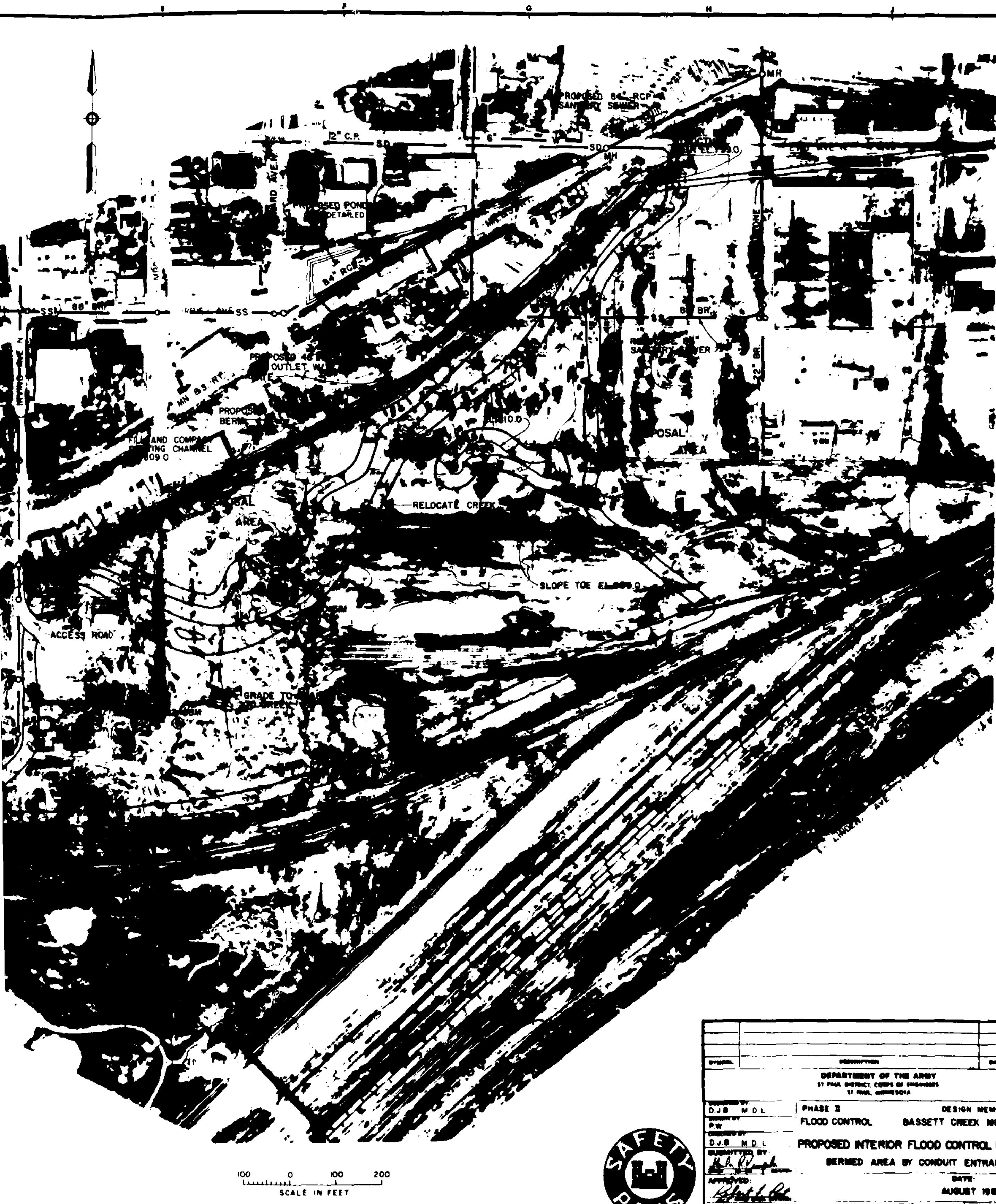
PROPOSED PLAN



B.N. R.R.
BASSETT CREEK
MN. & S. R.R.
PROPOSED 30" RCP OUTLET W/ FLAP GATE
SCALE IN FEET
PROPOSED PLAN
SAFETY PAYS
PROPOSED INTERIOR FLOOD CONTROL FEATURES
GLENWOOD - INGLEWOOD PONDING AREA
FRUEN MILL AREA BELOW GLENWOOD AVENUE
JUNE 1982
AS SHOWN

PLATE B-3

ACCESS ROAD
27" C.P.
88" CMP
PROPOSED BERM
FILL AND COMPACT EXISTING CHANNEL
809.0
NOTE ALL SIDE SLOPES ARE 1V ON 3H
PROPOSED PONDING AREA
DETAILED DRAWING
50 0 50 100
SCALE IN FEET



DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

DESIGNED BY: D.J.B M D L	PHASE II DESIGN MEMORANDUM
DRAWN BY: P.W	FLOOD CONTROL BASSETT CREEK MINNESOTA
CHECKED BY: D.J.B M D L	PROPOSED INTERIOR FLOOD CONTROL FEATURES
SUBMITTED BY:	BERMED AREA BY CONDUIT ENTRANCE
APPROVED:	DATE: AUGUST 1982

SHEET OF

2

PLATE B-4

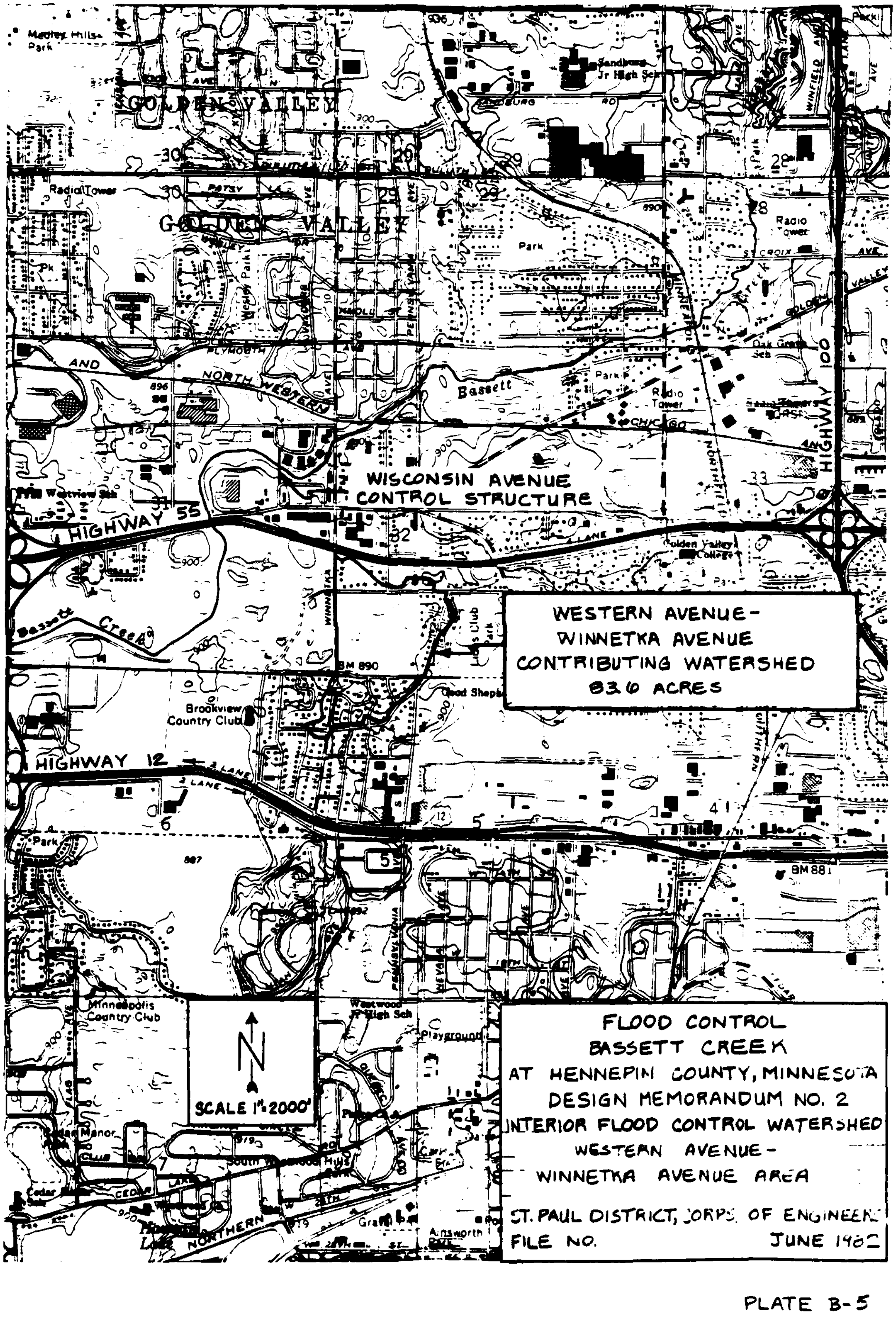

GOLDEN VALLEY
WISCONSIN AVENUE
CONTROL STRUCTURE
HIGHWAY 55
HIGHWAY 12
HIGHWAY 100
Bassett Creek
Brookview Country Club
Minneapolis Country Club
WESTERN AVENUE-
WINNETKA AVENUE
CONTRIBUTING WATERSHED
83.6 ACRES
N
SCALE 1"=2000'
FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
INTERIOR FLOOD CONTROL WATERSHED
WESTERN AVENUE-
WINNETKA AVENUE AREA
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO.
JUNE 1962

PLATE B-5

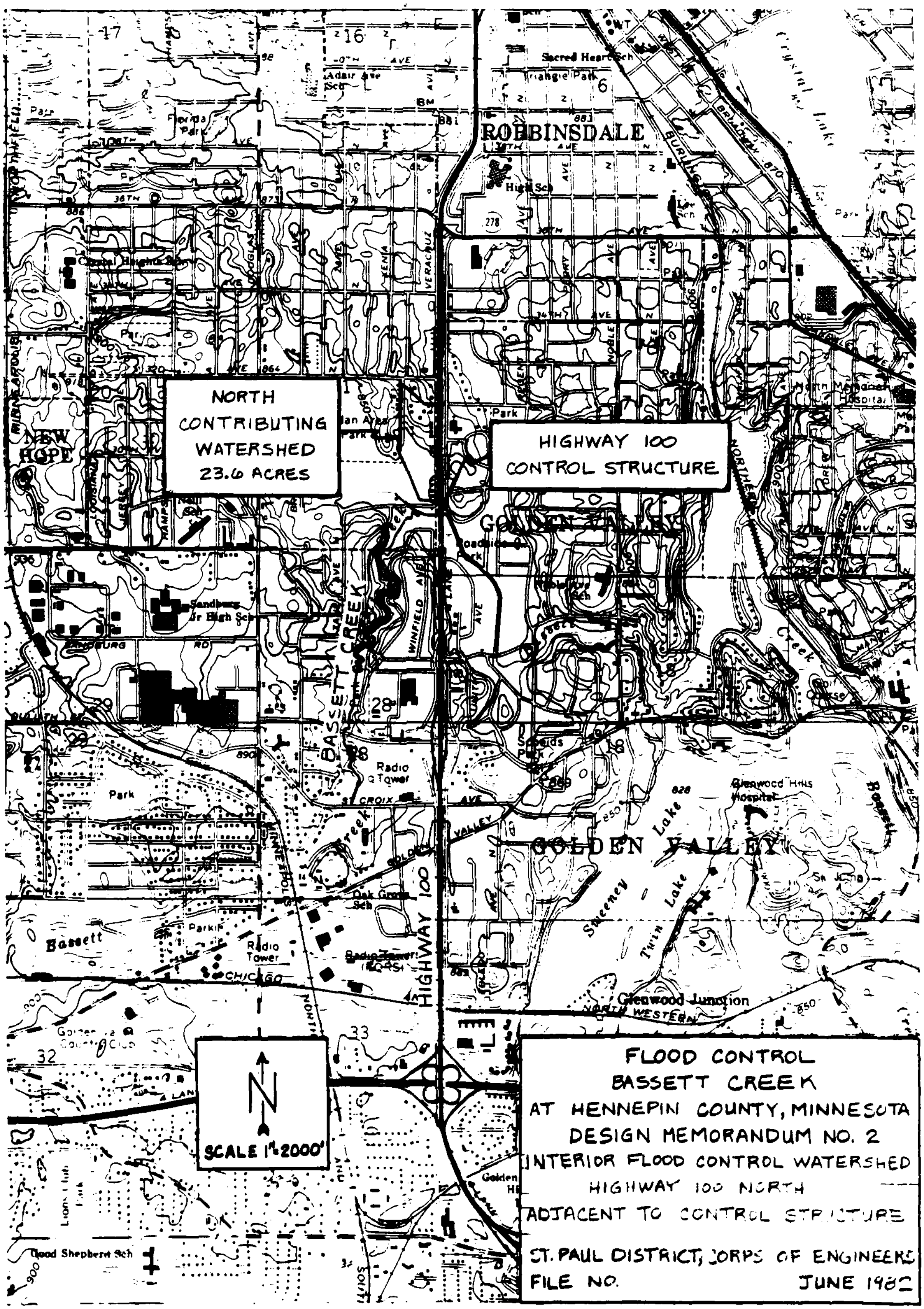
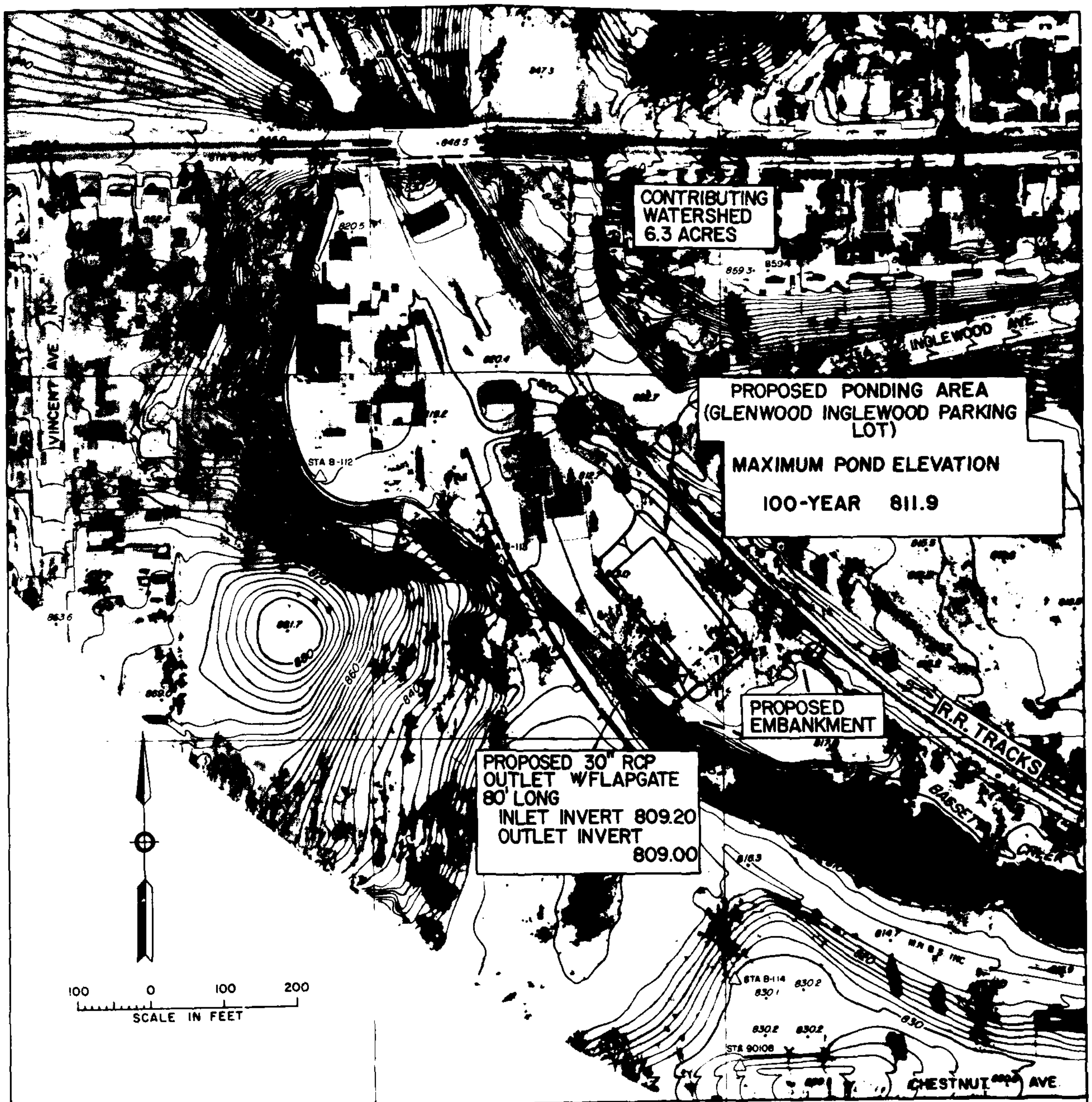

NORTH CONTRIBUTING WATERSHED 23.6 ACRES
HIGHWAY 100 CONTROL STRUCTURE
ROBBINSDALE
NEW HOPE
GOLDEN VALLEY
BASSETT CREEK
HIGHWAY 100
Sandburg Jr High Sch
Sacred Heart Sch
Glenwood Junction
Twin Lake
Sweeney Lake
Glenwood Hills Hospital
SCALE 1"=2000'
FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
INTERIOR FLOOD CONTROL WATERSHED
HIGHWAY 100 NORTH
ADJACENT TO CONTROL STRUCTURE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO.
JUNE 1982

PLATE B-6



DESIGN MEMORANDUM NO. II
PHASE II

FLOOD CONTROL
BASSETT CREEK WATERSHED
MINNEAPOLIS, MINNESOTA

INTERIOR FLOOD CONTROL WATERSHED AND PROPOSED PONDING AREA FRUEN MILL AREA BELOW GLENWOOD AVE.

ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. M34.3-R-5/135 JUNE 1982

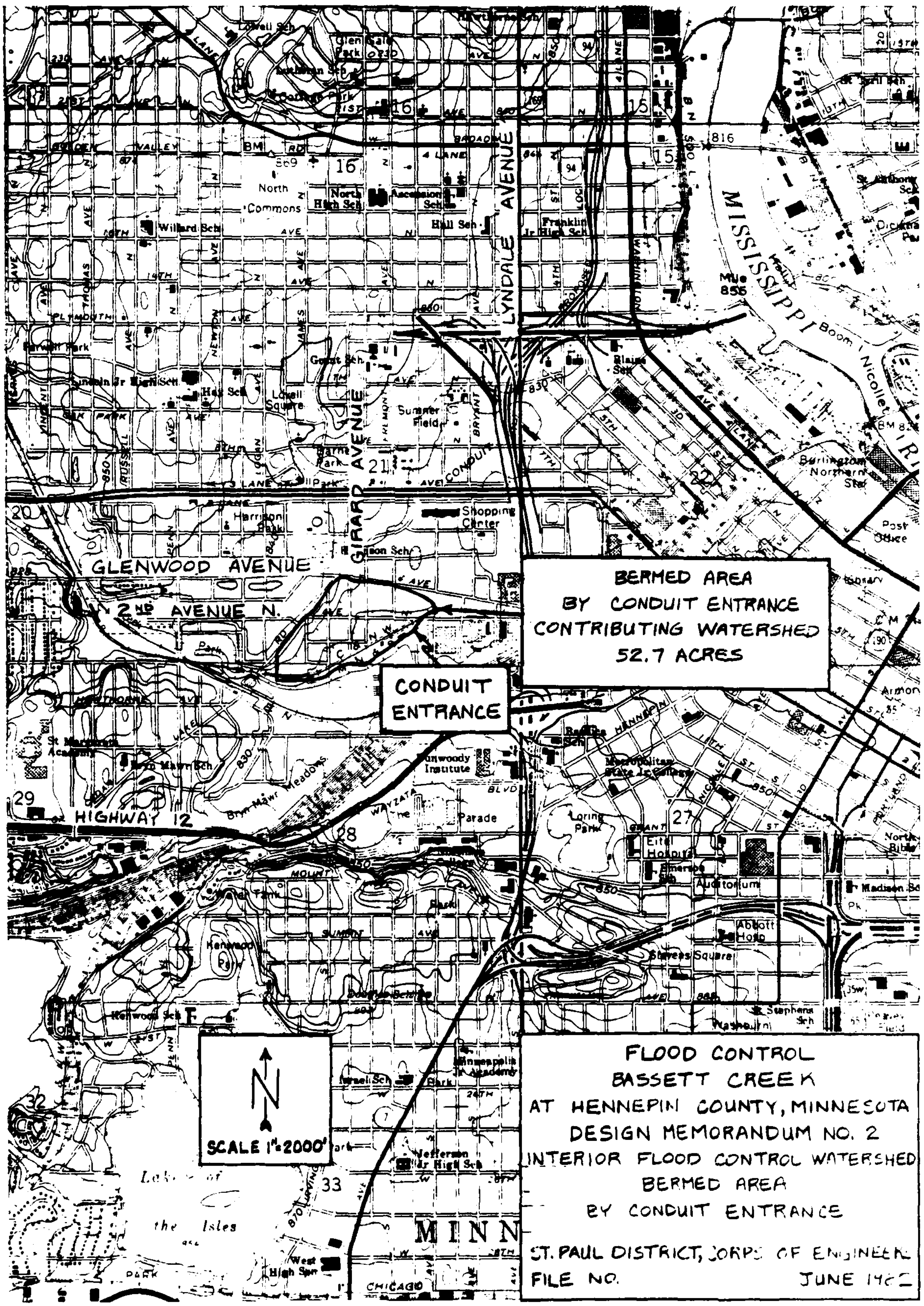
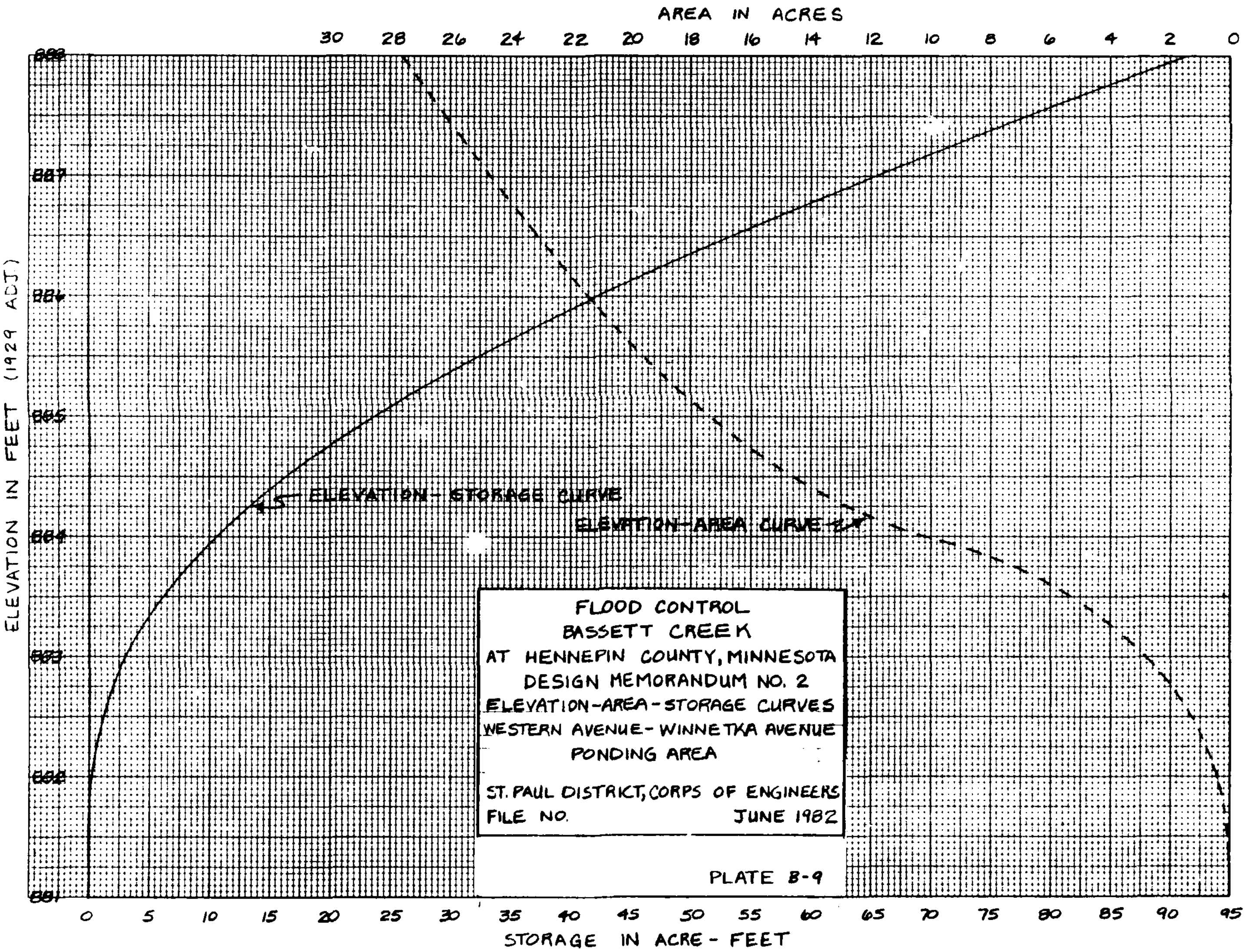

BERMED AREA
BY CONDUIT ENTRANCE
CONTRIBUTING WATERSHED
52.7 ACRES
CONDUIT ENTRANCE
GLENWOOD AVENUE
2ND AVENUE N.
HIGHWAY 12
GIRARD AVENUE
LYNDALE AVENUE
MISSISSIPPI
SCALE 1"=2000'
FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
INTERIOR FLOOD CONTROL WATERSHED
BERMED AREA
BY CONDUIT ENTRANCE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO.
JUNE 1982

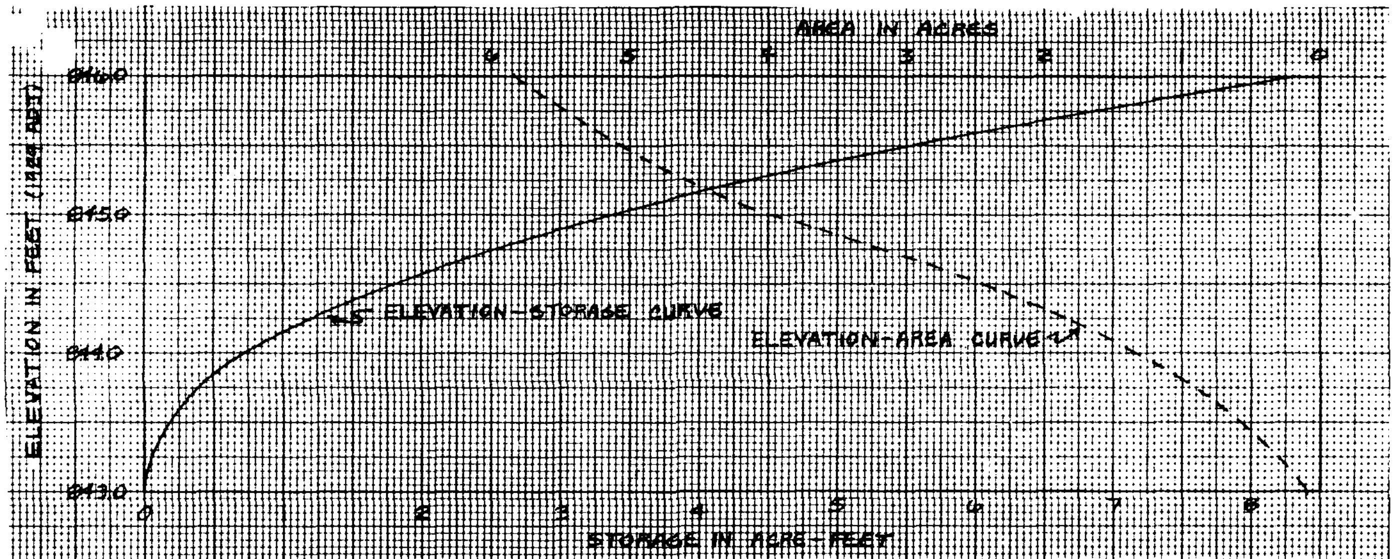
PLATE 2-8



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
ELEVATION-AREA-STORAGE CURVES
WESTERN AVENUE - WINNETKA AVENUE
PONDING AREA

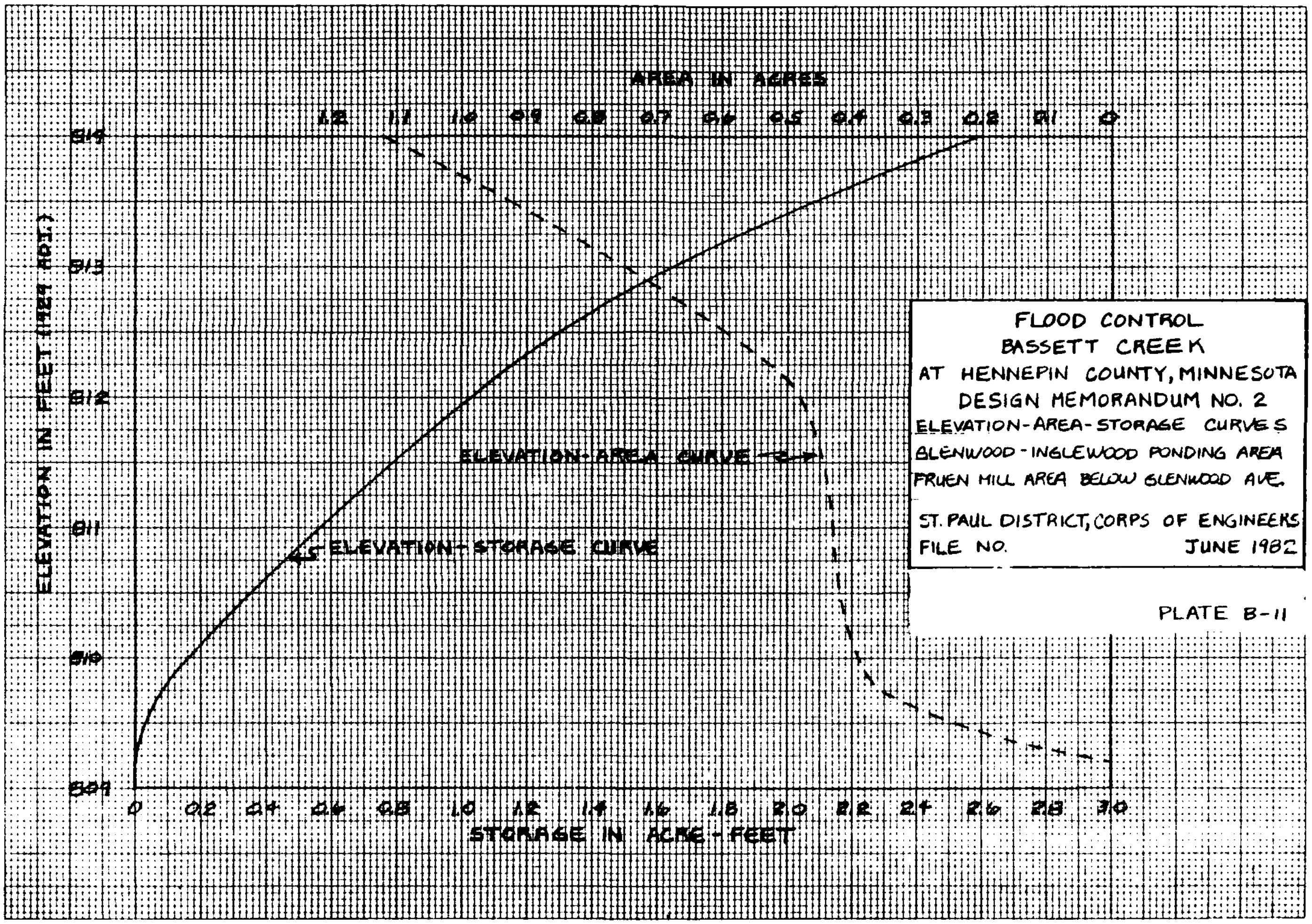
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

PLATE B-9



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
ELEVATION-AREA-STORAGE CURVES
HIGHWAY 100 NORTH
PONDING AREA

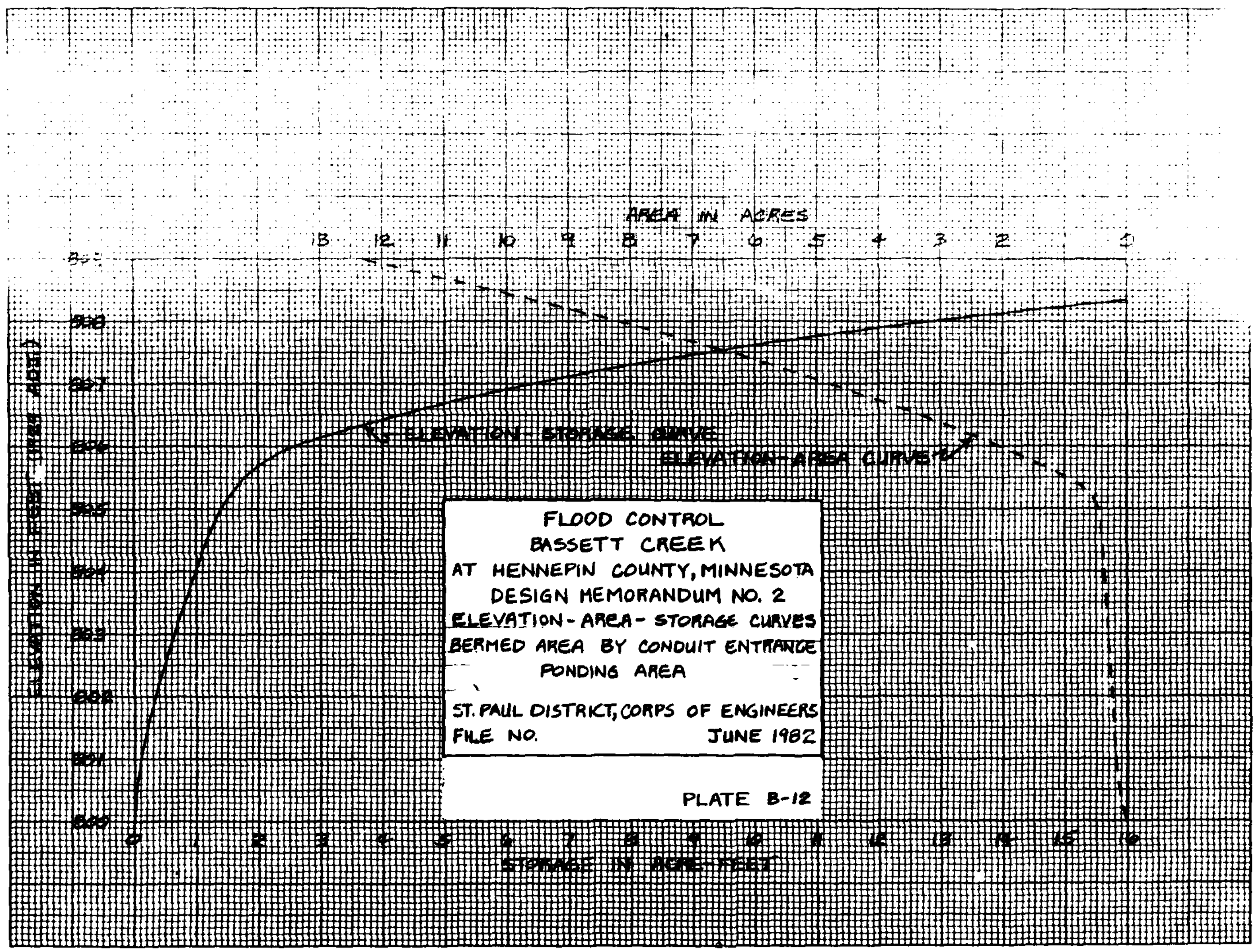
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

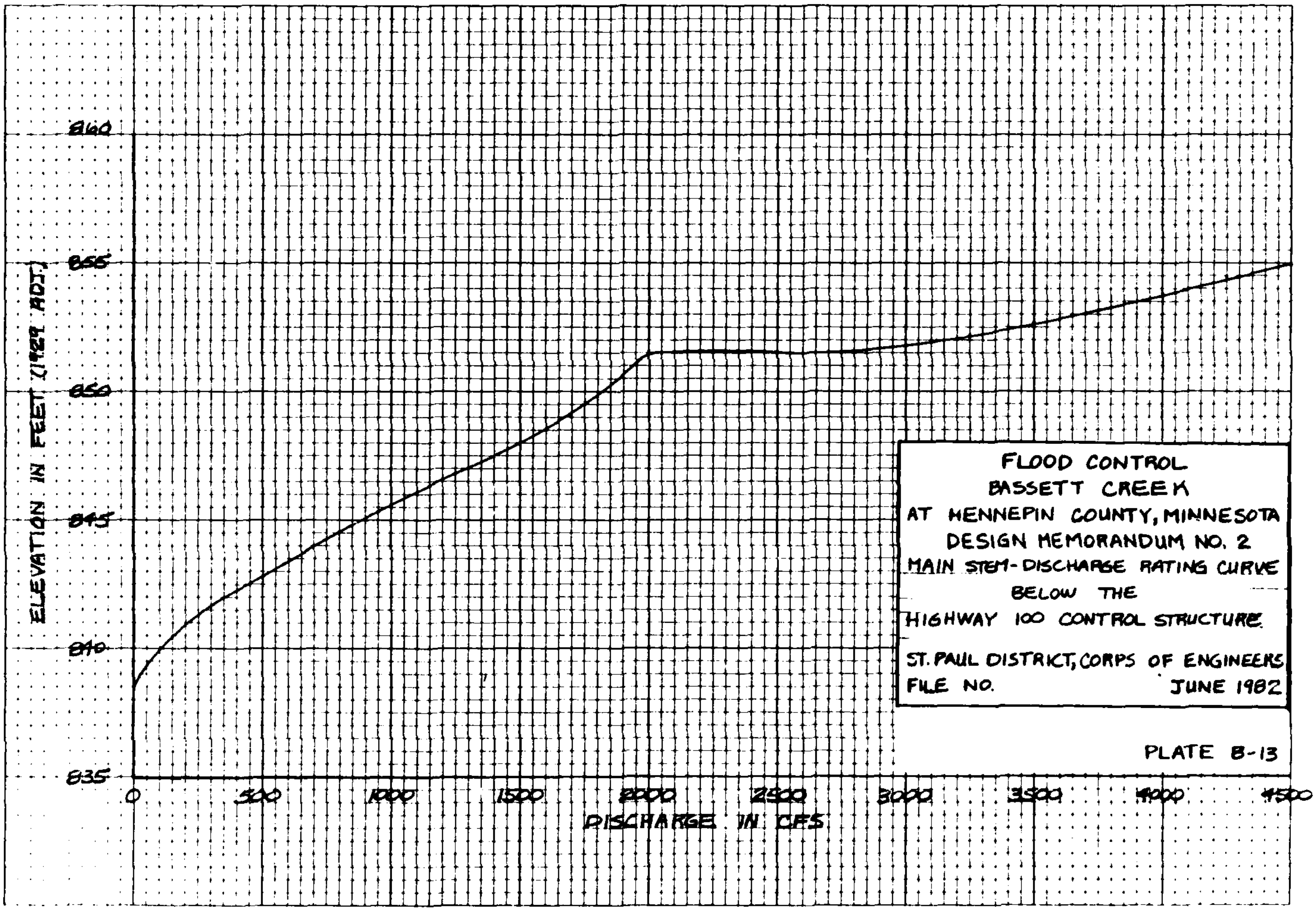


FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
ELEVATION-AREA-STORAGE CURVES
GLENWOOD-INGLEWOOD PONDING AREA
FRUEN MILL AREA BELOW GLENWOOD AVE.

ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

PLATE B-11

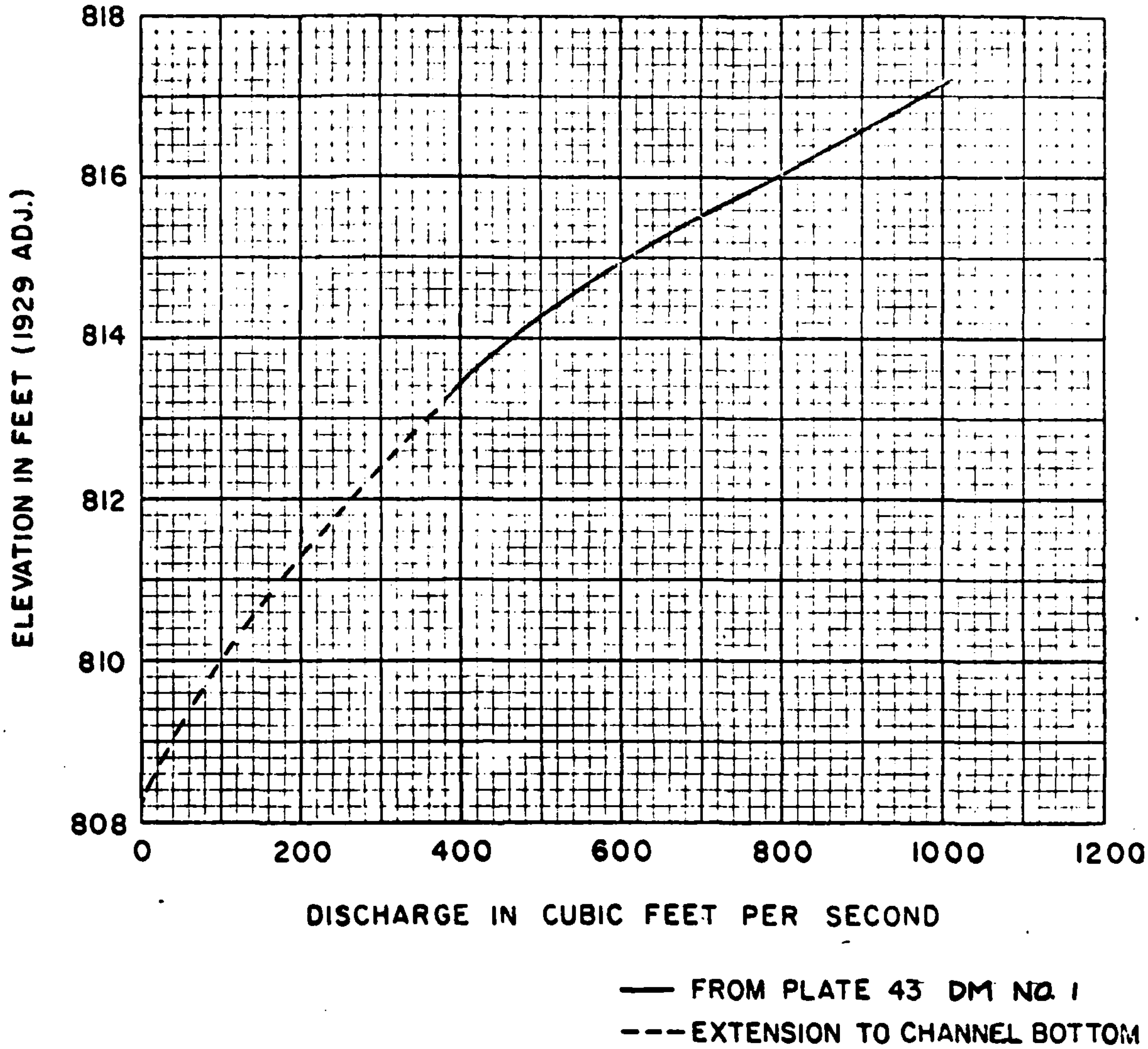

AREA IN ACRES
ELEVATION IN FEET (MEAN SEA LEVEL)
ELEVATION - STORAGE CURVE
ELEVATION-AREA CURVE
STORAGE IN ACRE-FEET
FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
ELEVATION - AREA - STORAGE CURVES
BERMED AREA BY CONDUIT ENTRANCE
PONDING AREA
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO.
JUNE 1982
PLATE B-12



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
MAIN STEM-DISCHARGE RATING CURVE
BELOW THE
HIGHWAY 100 CONTROL STRUCTURE

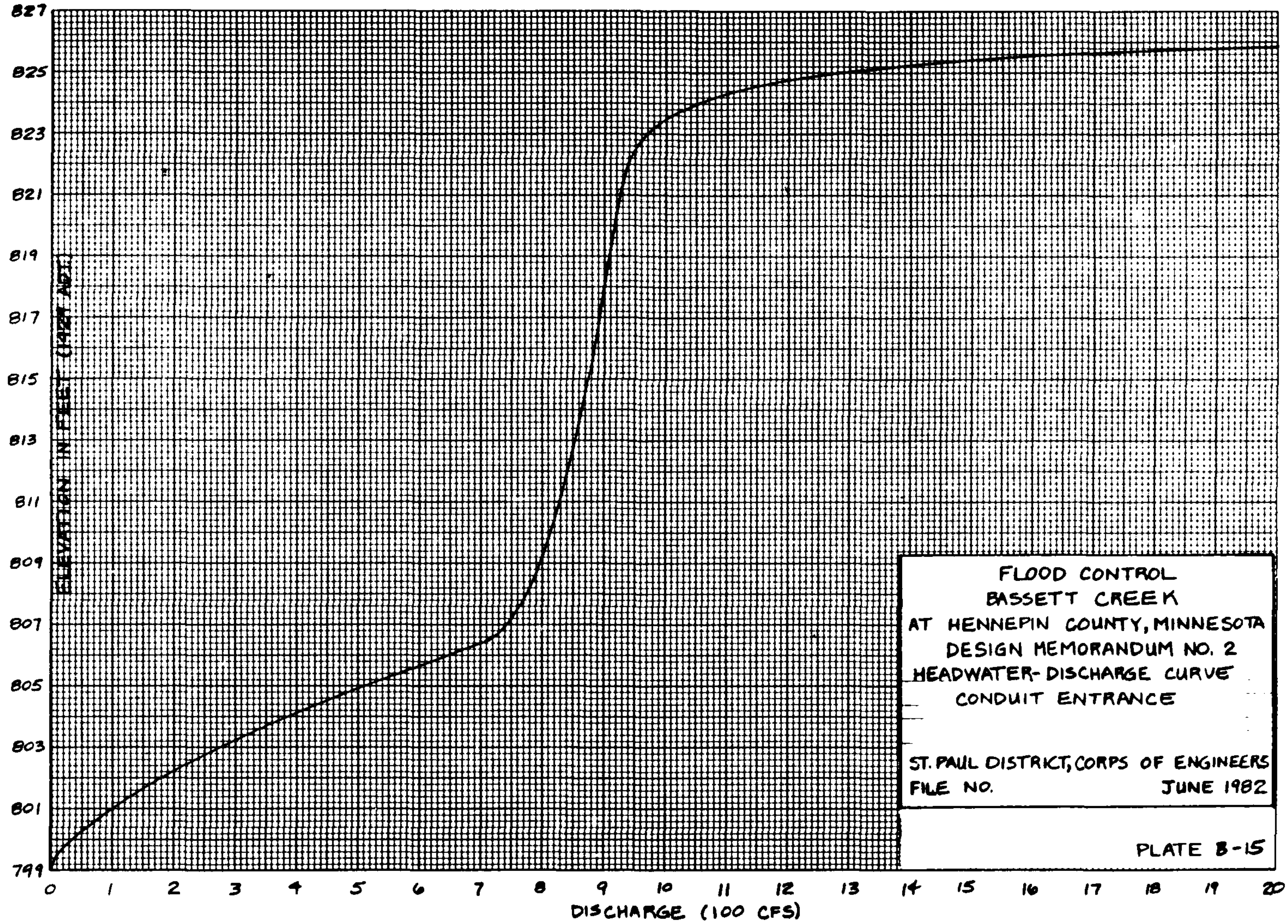
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

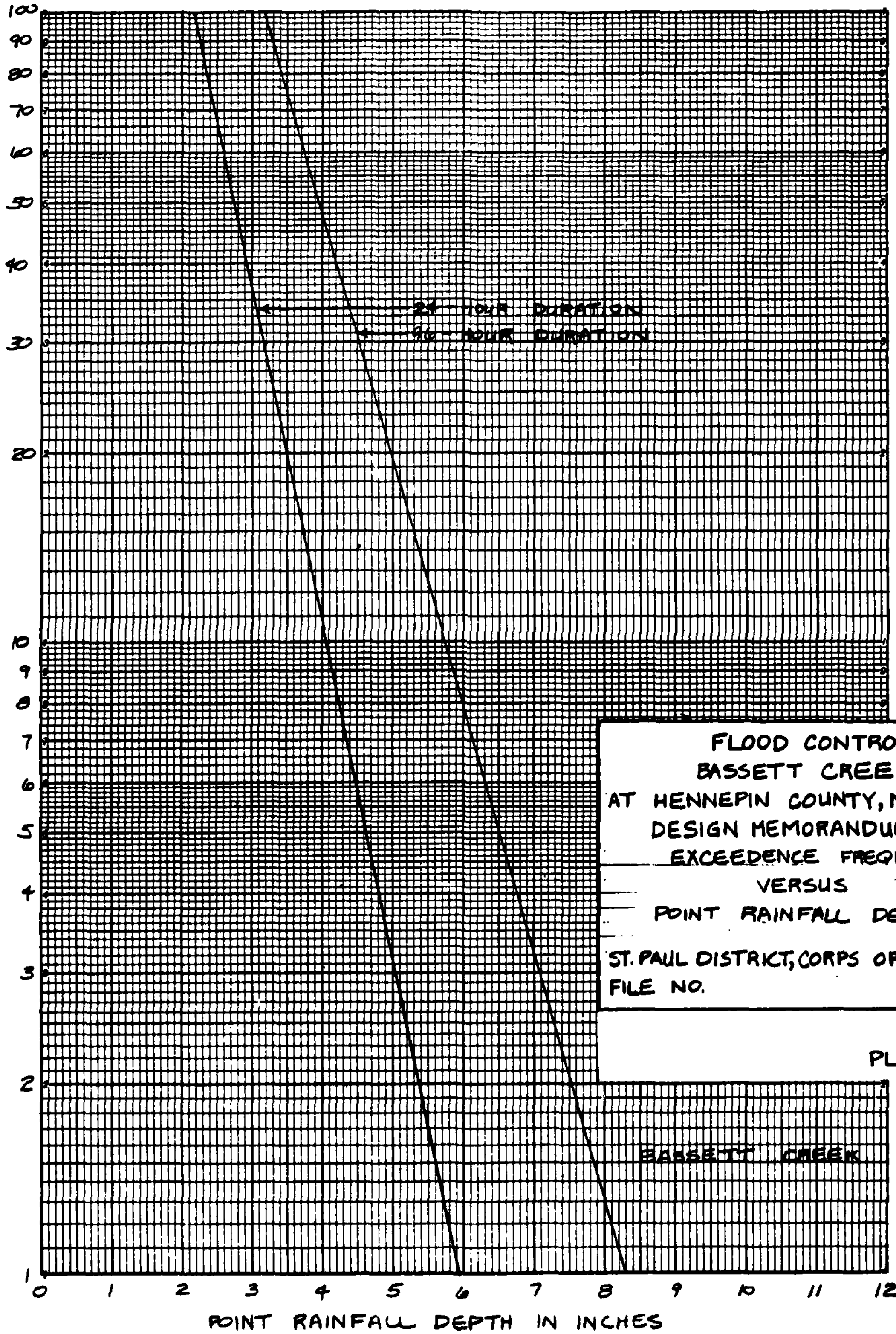
PLATE B-13



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
MAIN STEM - DISCHARGE RATING CURVE
AT CROSS SECTION 4.101
FRUEN MILL AREA BELOW GLENWOOD AVE.
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

PLATE B-14


827
825
823
821
819
817
815
813
811
809
807
805
803
801
799
ELEVATION IN FEET (1929 ADJ.)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
DISCHARGE (100 CFS)
FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
HEADWATER-DISCHARGE CURVE
CONDUIT ENTRANCE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO.
JUNE 1982
PLATE B-15



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2

EXCEEDENCE FREQUENCY
VERSUS
POINT RAINFALL DEPTHS

ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

PLATE B-16

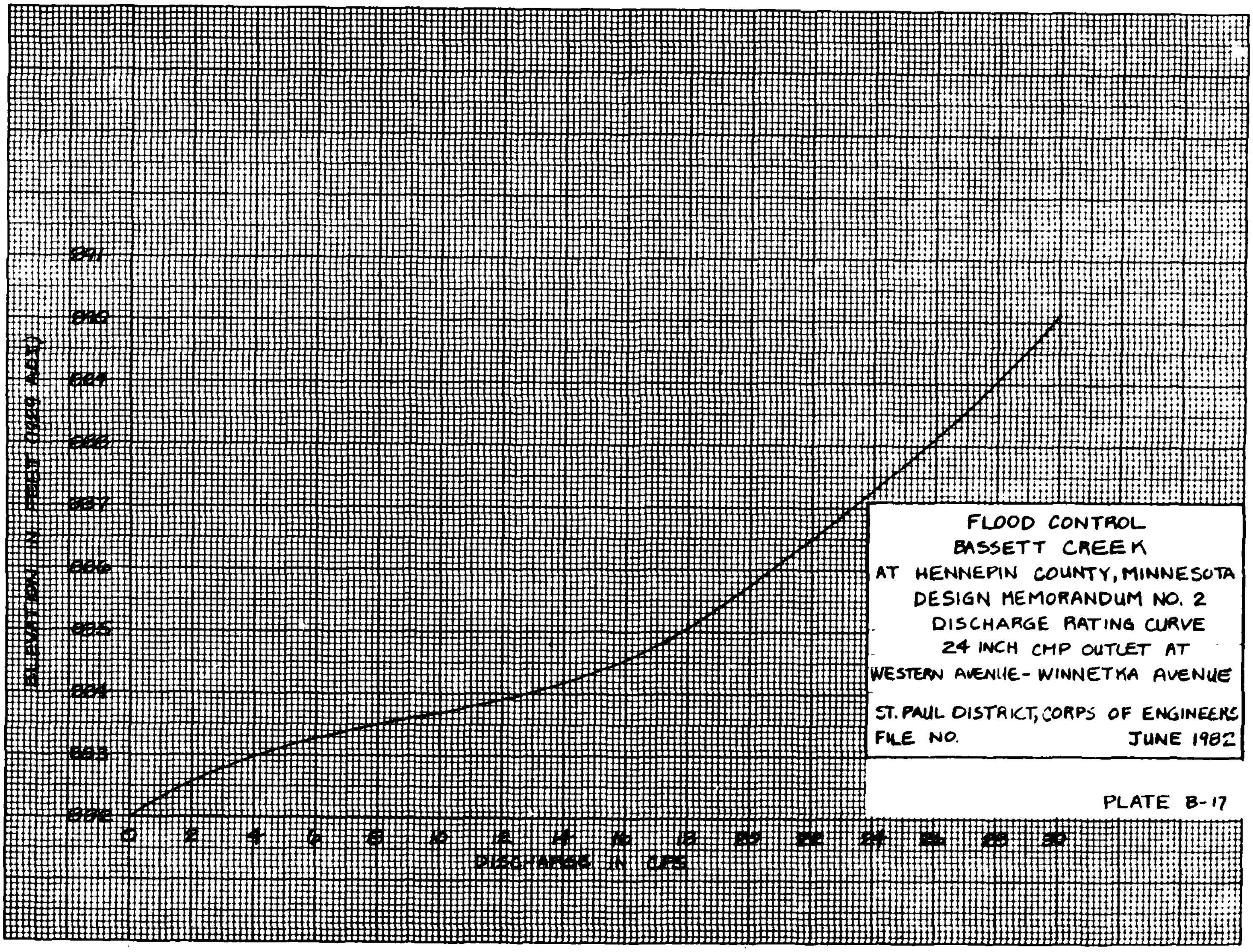
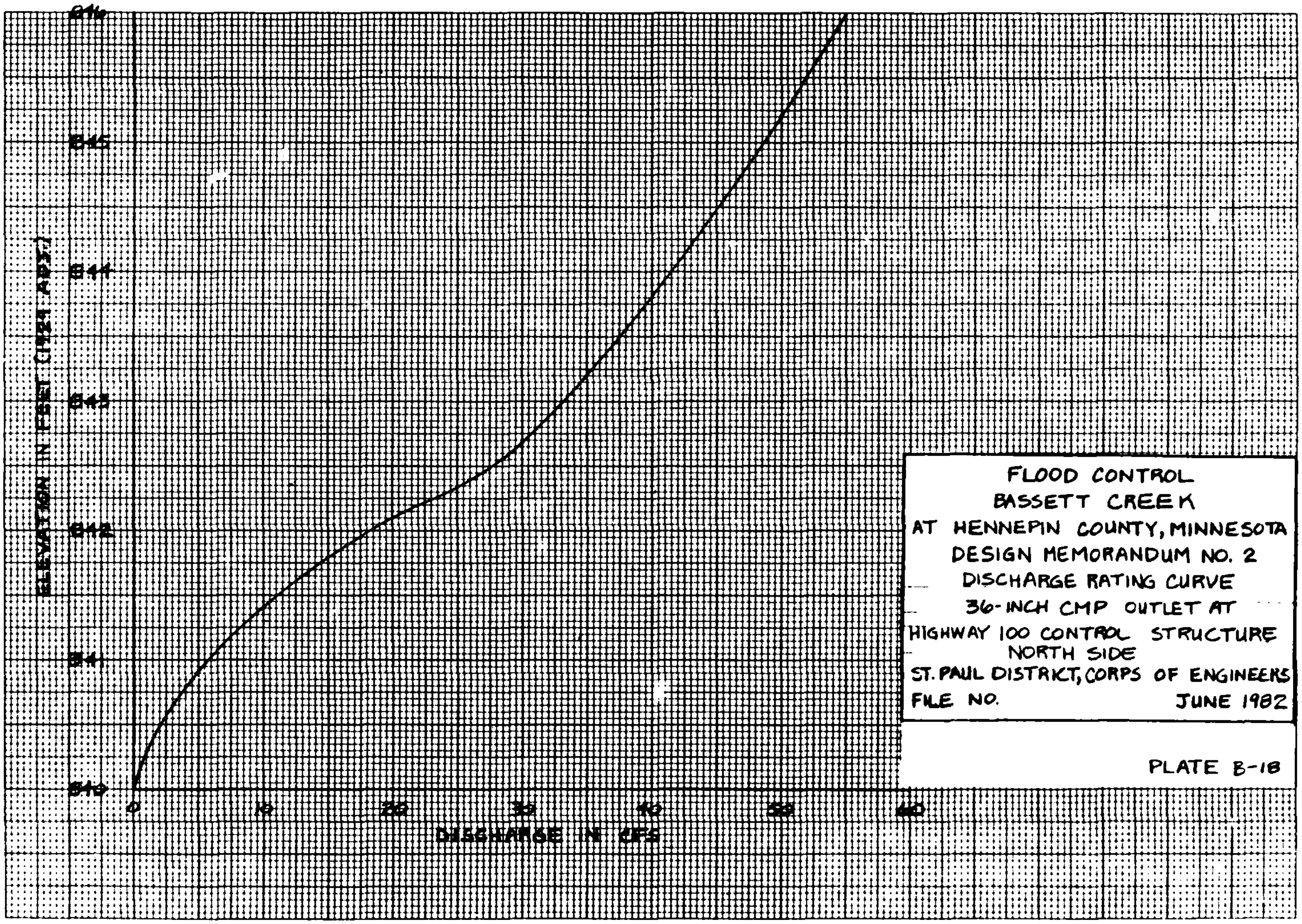
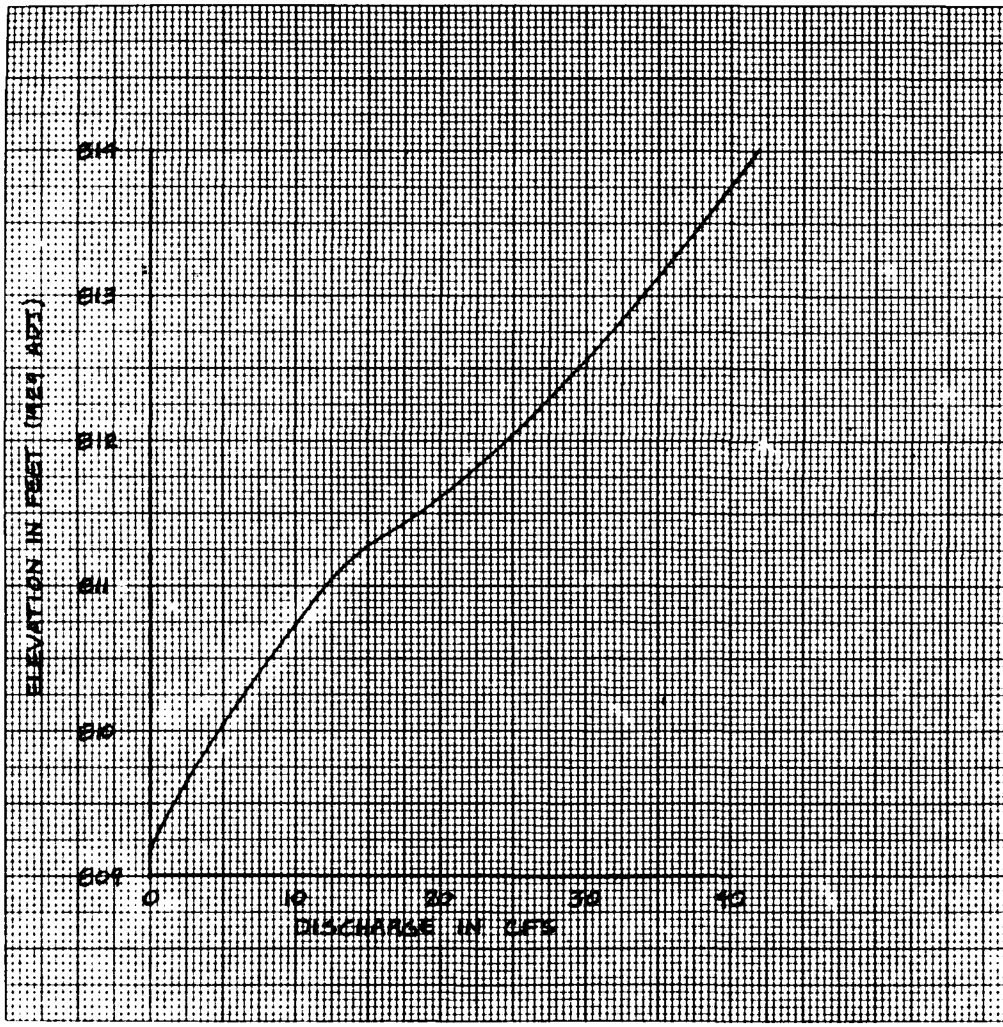

DISCHARGE IN CFS
FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
DISCHARGE RATING CURVE
24 INCH CMP OUTLET AT
WESTERN AVENUE - WINNETKA AVENUE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO.
JUNE 1982

PLATE B-17



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
DISCHARGE RATING CURVE
36-INCH CMP OUTLET AT
HIGHWAY 100 CONTROL STRUCTURE
NORTH SIDE
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

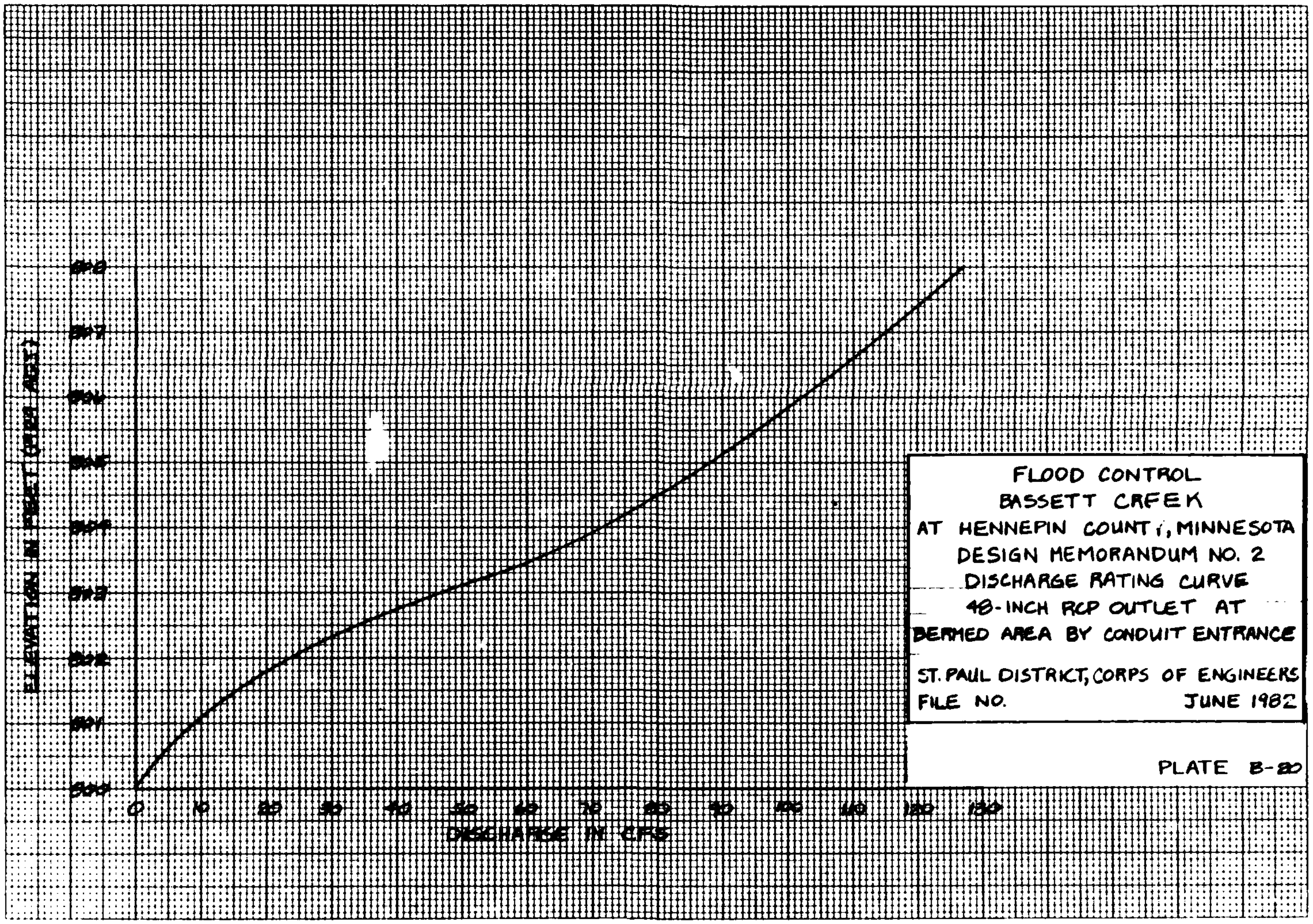
PLATE B-18



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
DISCHARGE RATING CURVE
30 INCH RCP OUTLET AT
FRUEN MILL AREA BELOW GLENWOOD AVE.

ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

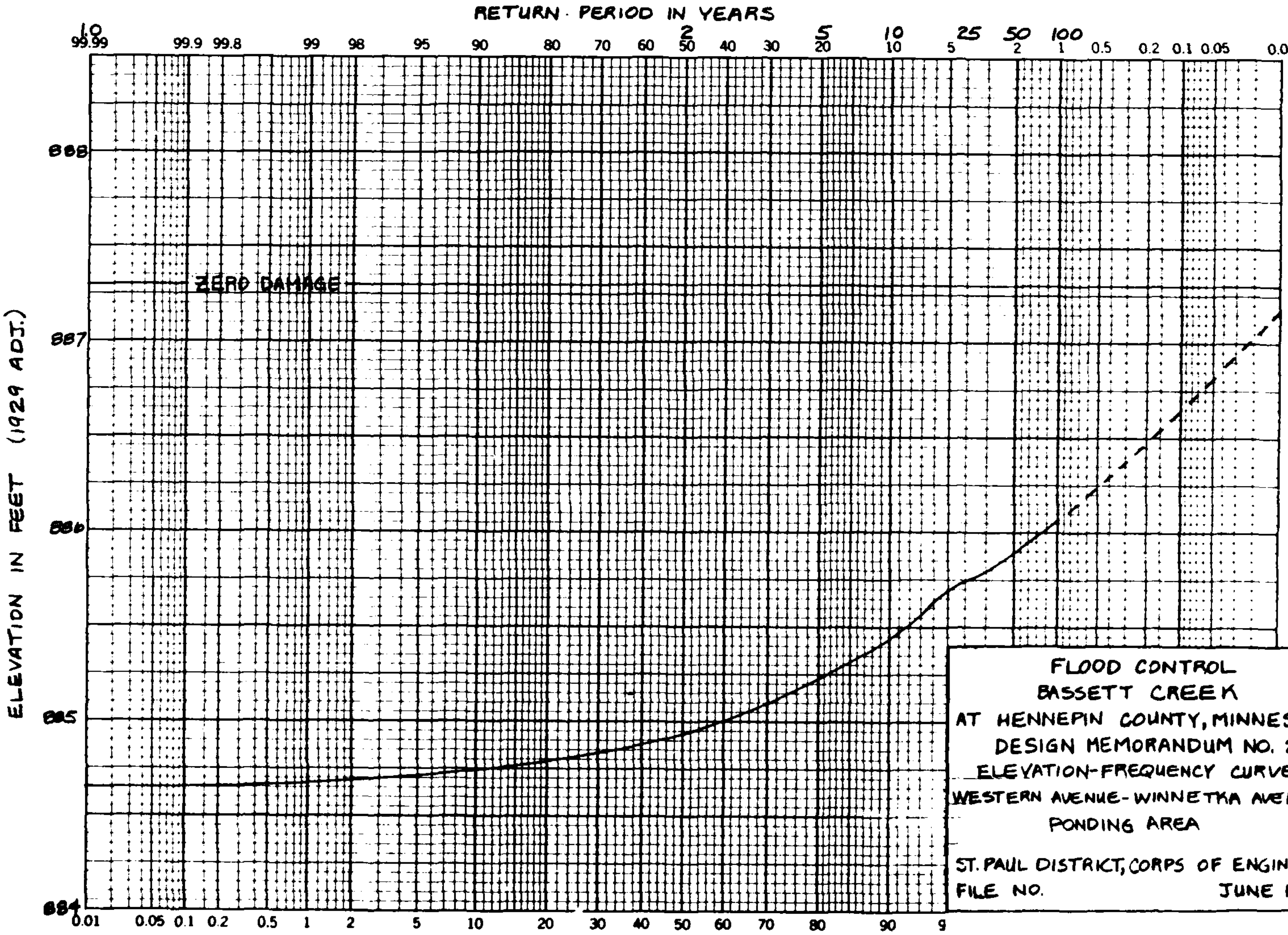
PLATE B-19



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
DISCHARGE RATING CURVE
48-INCH RCP OUTLET AT
BERMED AREA BY CONDUIT ENTRANCE

ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

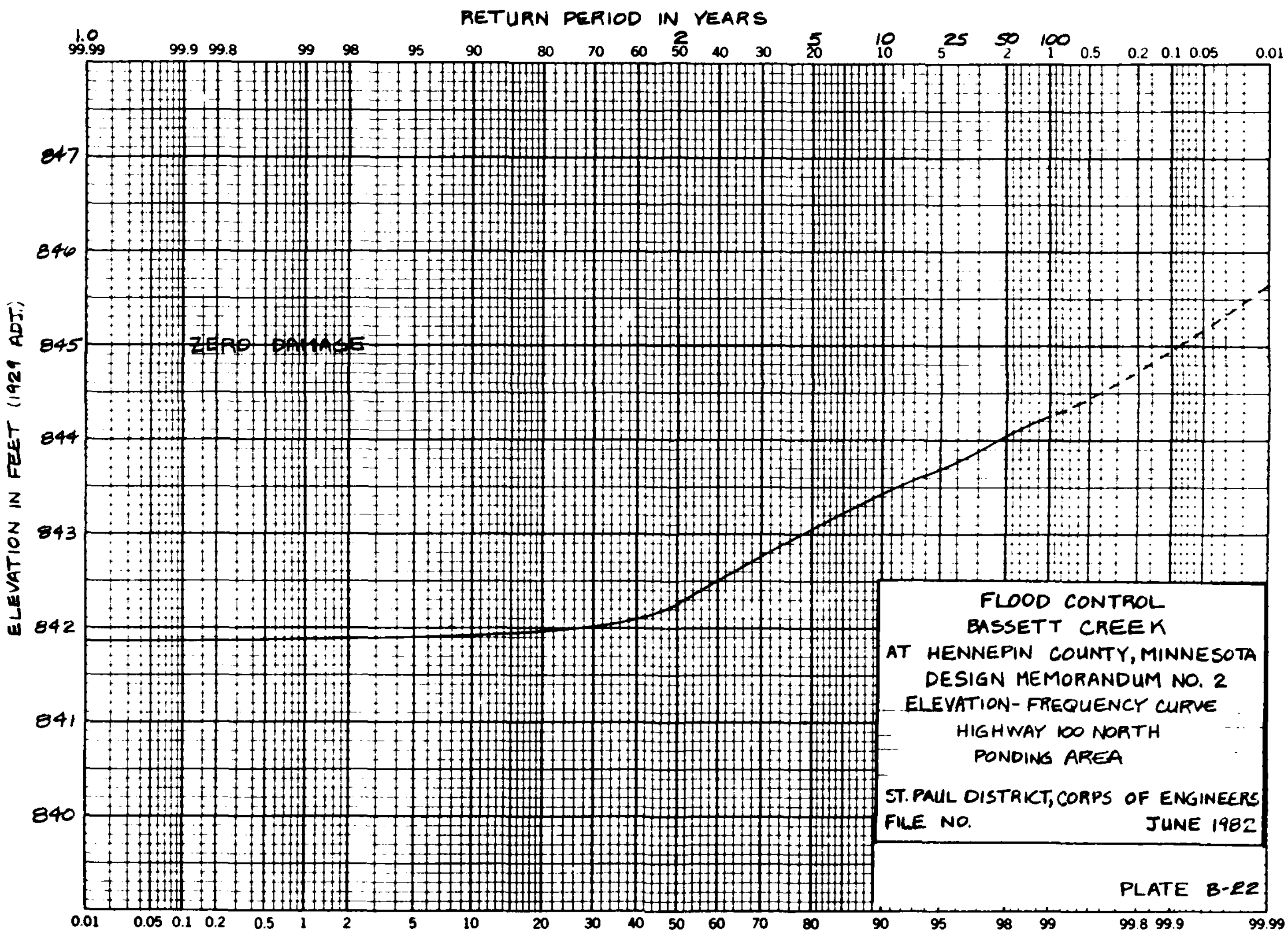
PLATE B-20

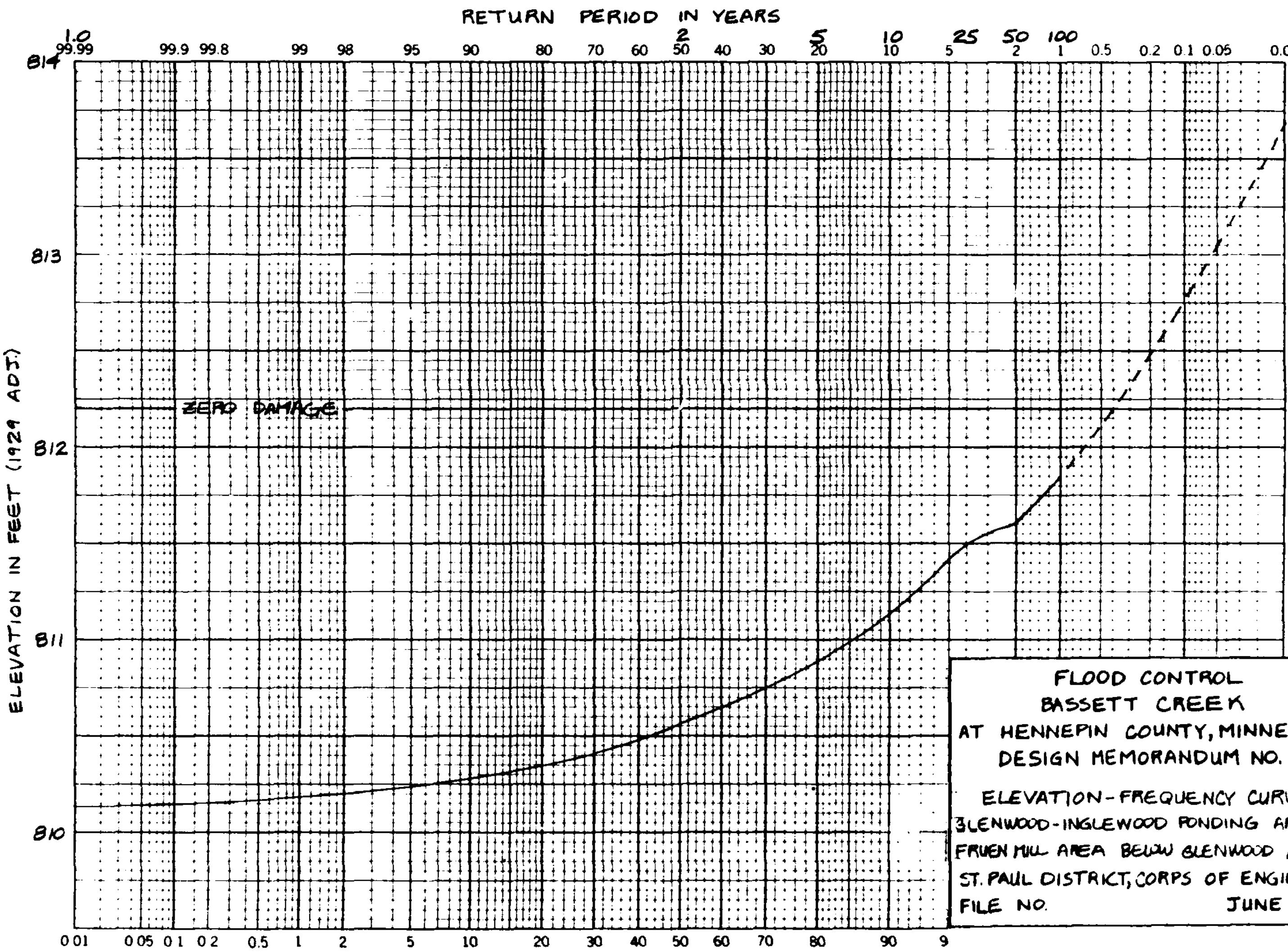


FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
ELEVATION-FREQUENCY CURVE
WESTERN AVENUE-WINNETKA AVENUE
PONDING AREA

ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

PLATE B-21

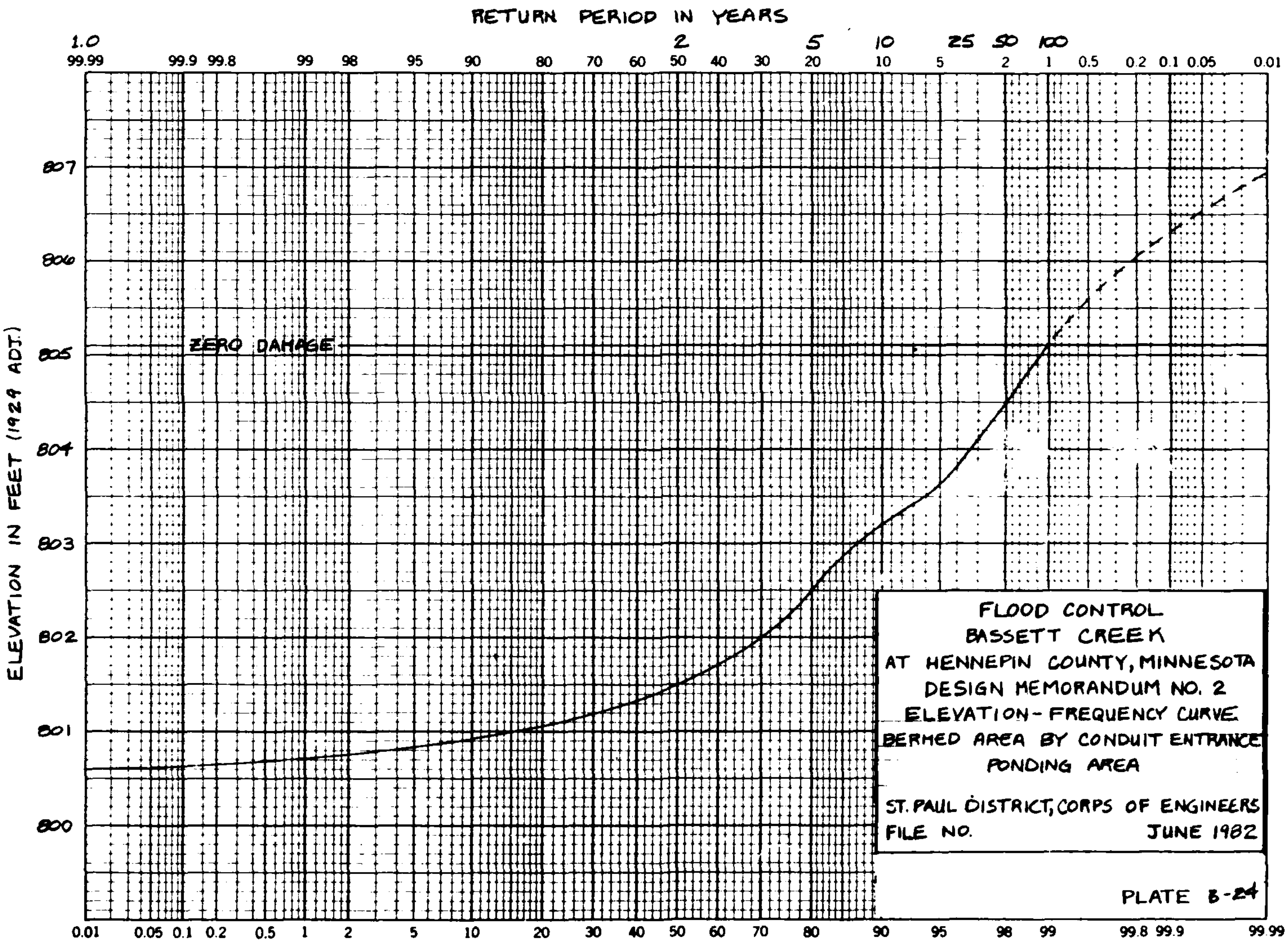

RETURN PERIOD IN YEARS
1.0
2
5
10
25
50
100
ELEVATION IN FEET (1929 ADJ.)
847
846
845
844
843
842
841
840
ZERO DAMAGE
FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
ELEVATION- FREQUENCY CURVE
HIGHWAY 100 NORTH
PONDING AREA
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO.
JUNE 1982
PLATE B-22



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2

ELEVATION-FREQUENCY CURVE
GLENWOOD-INGLEWOOD PONDING AREA
FRUEN MILL AREA BELOW GLENWOOD AVE.
ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

PLATE B-23



FLOOD CONTROL
BASSETT CREEK
AT HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2
ELEVATION-FREQUENCY CURVE
BERMED AREA BY CONDUIT ENTRANCE
PONDING AREA

ST. PAUL DISTRICT, CORPS OF ENGINEERS
FILE NO. JUNE 1982

PLATE B-24

DEPARTMENT OF THE ARMY
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX C

GEOLOGY AND SOILS

Table of Contents

Table of Contents (con.)

Table of Contents (con.)

Tables

Plates

Plates (con.)

Plates (con.)

APPENDIX C

GENERAL TOPOGRAPHY AND GEOLOGY

1. The topography and most of the geology important to the Bassett Creek project are products of Pleistocene and Recent sedimentation and erosion. That portion of the geologic history is, therefore, summarized to provide background for understanding the physical setting of the project.

2. At the beginning of the Pleistocene Epoch, the area consisted of broad uplands and deep bedrock valleys similar to conditions that now exist farther south along the Mississippi River. Glaciers advanced several times over this setting throughout the Pleistocene, but little evidence of early glaciations persist due to erosion during long interglacial stages. The final two glacial advances which occurred during the Wisconsin Stage, however, completely filled the old valleys with debris and developed a new landscape with only subtle reflections of the preglacial topography.

3. Immediately following the retreat of the glaciers, the Bassett Creek basin consisted of a hummocky till and outwash plain with scattered blocks of ice that later melted and left depressions which became lakes, bogs and marshes that were subsequently filled with peat, soft clay and silt. Bassett Creek now meanders through this glaciated terrain in a channel less than 50 feet wide and at most a few feet deep. In some areas it has cut a small valley through glacial till knolls, but throughout most of its length it flows through low areas with no identifiable valley and in which drainage has been improved by ditching or enlarging and cleaning the small, natural channel. The creek flows in an underground conduit from 2nd Avenue North to the Mississippi River. The total relief in the basin is 210 feet, but local relief is generally less than 70 feet. In much of the area the natural topography has been altered by leveling and filling for residential and commercial development.

4. The thickness of the overburden and the underlying types of bedrock vary greatly throughout the basin due to the presence of buried preglacial valleys. Most of the project features are small and affect the subsurface to only a shallow depth; therefore, accurate definition of the depth to bedrock and the bedrock stratigraphy are not important considerations. A general geologic column is provided for background information, and additional bedrock information is presented when important in the discussion of specific features.

5. Upstream of the proposed tunnel entrance where Bassett Creek intersects 2nd Avenue North, bedrock is of little concern. The geology pertinent to the project consists of soft alluvial silts and clays, bog deposits of peat, organic-rich silts and clays resting on medium dense glacial sands and tills. Along the proposed tunnel heading the materials consist of Mississippi River terrace deposits of soft clays, silts and medium dense sand, medium dense to dense glacial drift and sandstone bedrock of the St. Peter Formation.

TABLE 1

GENERAL GEOLOGIC COLUMN FOR BASSETT CREEK DRAINAGE BASIN

SYSTEM	FORMATION		APPROXIMATE THICKNESS (feet)	DESCRIPTION
QUATERNARY	Recent Sediments		0-50	Soft clay, silt and peat
	Glacial Drift		25-350	Medium dense to dense sand, gravel and glacial till
ORDOVICIAN	Platteville Formation		Up to 30	Dolomitic limestone, thin to medium bedded, gray
	Glenwood Formation		Up to 5	Shale, soft, blue-gray
	St. Peter Formation		150	Sandstone, fine to medium, well-sorted, quartzose, poorly cemented, 50' of siltstone and moderately cemented sandstone near base, white to gray
	Prairie du Chien Group	Shakopee Formation	50	Dolomite, thin-bedded, light brown
		Oneota Formation	75	Dolomite, thin to thick bedded, brown
CAMBRIAN	Jordan Formation		90	Sandstone, fine to coarse, massive, brown
	St. Lawrence Formation		50	Dolomitic siltstone and fine dolomitic sandstone, gray to gray-green
	Franconia Formation		190	Sandstone with interbeds of siltstone and shale, white to gray and green
	Galesville Formation		35	Sandstone, medium to coarse, yellow
	Eau Claire Formation		Up to 150	Sandstone, siltstone and shale, brown
	Mt. Simmon Formation		Up to 200	Sandstone, medium to coarse, gray
KEWEENAWAN	Hinckley Sandstone		Up to 200	Sandstone, medium to coarse, buff to red
	Red Clastics		Up to 4000	Sandstone, silty, feldspathic, fine, includes red shale
	Volcanic Rocks		Up to 20000	Mafic lava flows with thin interbeds of tuff and breccia

6. Bassett Creek is a local discharge corridor for ground water as well as surface water and, as such, is the low point in the water table throughout most of the basin. Except for unwatering required for construction of the tunnel portion of the project, the proposed work will have no temporary or long-term effect on the ground water of the basin.

SUBSURFACE INFORMATION AND LABORATORY TEST DATA

7. BORINGS

A total of 65 Corps of Engineers (USCE) machine borings were taken for various features throughout the Bassett Creek watershed. In addition, 46 borings were taken in the Highway 100 Embankment, Edgewood Embankment and Tunnel areas by other engineering organizations. The locations of the borings are shown on plan views of the individual structures. Logs of the borings are grouped separately for each structure and are shown either on the plan view sheet in the main report or on separate plates in this appendix. Borings taken for features that have been deleted are not shown in this report.

8. LABORATORY TEST DATA

Laboratory tests performed to date include moisture contents, Atterberg limits, mechanical analysis, undisturbed and remolded triaxial and direct shears, compaction and consolidation tests. Moisture contents, Atterberg limits and standard penetration test results are shown on the boring logs. Laboratory test results are presented on Plates C-17 to C-39.

9. The undisturbed samples from USCE drilling were obtained from borings offset slightly from a pilot hole while undisturbed sampling by others was obtained at preselected depths within the pilot hole. The USCE sampling procedure permits preselection of sampling depths on the basis of information shown on the log of the pilot boring and, therefore, provides samples that are more representative of foundation materials. Where this procedure was used, the offset boring number appears on individual laboratory test results, but subsurface conditions are shown by the detailed log of the pilot boring. Also the boring number of the pilot hole is used to show the location of both borings in plan. Therefore, boring numbers ending with the letters MU (80-42MU) that appear on USCE test results represent borings slightly offset from a pilot boring having the same prefix numbers but ending with the letter M (80-42M).

10. The individual strength test results were used to develop summary plots whenever sufficient data was available for a given material at a specific site. The plates showing the strength plots are shown in this appendix.

BASSETT CREEK TUNNEL

11. GEOLOGY

The geology pertinent to the proposed tunnel is discussed using a

classification system presented in Miscellaneous Investigation Series Map 1-1157, Geologic and Hydrologic Aspects of Tunneling in the Twin Cities Area, by Norvitch and Walton and published by the United States Geological Survey in 1979. Information from this publication, boring logs obtained from the Minnesota Department of Transportation and a minimum number of site specific borings and laboratory tests to fill gaps in the information were used for this report. The basic data are considered adequate only for the development of design concepts and realistic cost estimates. Significant additional information will be needed for final design.

12. The interpreted subsurface conditions along the tunnel alignment are shown on Sheets 5 through 7 with materials classified according to the previously referenced system which is based on time and mode of deposition. Although variations of soil types within each overburden unit are known or expected, sufficient similarities of engineering properties of the components of each unit exist to justify the use of the system for the present level of planning. The stratigraphy and general engineering properties of the bedrock units are well established from extensive tunneling in the Minneapolis area. Site specific investigation and testing of bedrock were, therefore, not necessary for this report.

13. The general properties of the classification units are discussed in the following paragraphs. In addition, numerical values accepted as reasonable for the engineering properties of the various materials are summarized in Table 2. A discussion by stationing along the tunnel alignment summarizes identified considerations, problems and solutions in paragraphs 25 through 33.

14. OVERBURDEN

Overburden units within the influence of the tunnel are Fine-Grained Lower-Terrace Deposits (Qmq), Coarse-Grained Lower-Terrace Deposits (Qmz) and Undifferentiated Glacial Till, Outwash and Alluvium in Buried Bedrock Valleys (Quvf). Fill is, of course, present in many areas and is expected to consist of a variety of materials ranging from trash to clean sand. All identified fill material is above the tunnel heading. Fill is, therefore, not discussed as a separate unit.

15. Fine-Grained Lower-Terrace Deposits (Qmq)

Although fine-grained terrace sediments are classified along with the coarse terrace material as being deposited by the Mississippi River when it flowed at a much higher level than at present, the distribution pattern and texture suggest they may have been deposited later in backwater trapped behind a riverward terrace. In either case the sediments have never been consolidated by any natural overlying load. In some areas, however, they have been loaded by fill or structures in the urbanization of the area.

16. Fine-grained terrace deposits are composed of silt and clay with minor amounts of silty and clayey sand. The materials are very soft to soft with a penetration resistance measured by standard penetration tests commonly less than 3 blows per foot. Although blows as high as 21 were recorded for some material classified in this unit, they are exceptions and may be

TABLE 2

ENGINEERING PROPERTIES OF BASSETT CREEK SOILS AND BEDROCK

Units	Type	Dry Unit Weight (pcf)	Saturated Unit Weight (pcf)	Modulus of Elasticity (pcf)	Poissons Ratio	Coefficient of Earth Pressure at Rest	Void Ratio	Porosity (%)	Standard Penetration Test (BPF)	Compressive Strength (psf)	Ø (deg)
Qmq*	Clay	74	106	10	0.50	1.0	1.4	--	0-5	600	20
Qms**	Sand	-	130	2250	0.33	0.5	0.6	--	10-25	-	33
Quvf**	Clay	--	125	900	0.44	0.8	0.9	--	10-25	1500	29
Quvf**	Sand	--	135	9500	0.28	0.4	0.5	--	15-50	-	37
Osp***	Sandstone	126	-	$0.5\text{-}0.8\times10^5$	--	-	-	29	75/0.0-0.3'	$1.4\text{-}4.0\times10^5$	60

* values obtained from test data
** assumed values
*** values obtained from "Miscellaneous Investigation Series Map 1-1157, Geologic and Hydrologic Aspects of Tunneling in the Twin Cities Area."

attributed to obstructions or errors in classification. All material in this unit should be treated for planning purposes as soft clays and silts. These soils will be difficult to unwater and susceptible to subsidence if subjected to sustained unwatering effort. In addition, they will exhibit poor stability at the tunnel heading as well as in open cuts and shafts. Settlement above the tunnel due to loss of ground will, therefore, be extremely critical when tunneling in this material.

17. Coarse-Grained Lower-Terrace Deposits (Qmz)

The coarse-grained terrace deposits are more typical of river terrace sediments than are the soft, fine textured materials. They are composed primarily of fairly clean sand and gravel with lesser amounts of clay and silt. Some prominent clay and silt beds are, however, present. The material is predominantly medium dense to stiff with penetration resistances generally more than 15 blows per foot. The granular nature will facilitate unwatering the unit, but sufficient beds of clay and silt are present to cause problems with perched water and zones of undrained soil that may be unstable when encountered at a tunnel heading. Subsidence due to unwatering is a consideration but is not evaluated as a significant problem. Settlement above the tunnel due to lost ground is an important consideration and ground stabilization may be required in critical areas.

18. Undifferentiated Glacial Till, Outwash and Alluvium in Buried Bedrock Valleys (Quvf)

Information concerning the character of this unit was obtained primarily from boring logs provided by the Minnesota Department of Transportation. First-hand knowledge of the drilling characteristics and field inspection of materials are, therefore, lacking. The available data indicate the tunnel will be in clay with a penetration resistance of 10 to 20 blows per foot throughout most of this unit. The dominance of stiff clay may be a benefit or a liability depending on whether it is fairly homogeneous or highly variable in texture and structure. A good, uniform clay would require no unwatering and allow simple, repetitive tunneling procedures. A stratified or mixed unit with sandy phases would, on the other hand, be difficult to unwater and would cause support problems due to running ground at the tunnel heading. Present plans are based on an interpretation between the two extremes. Minor tunneling problems due to the presence of boulders in glacial till are expected. Boulders and poor quality weathered rock are also expected to be problem elements where the tunnel goes from glacial material into bedrock.

19. BEDROCK

The tunnel will penetrate only the St. Peter Formation and will be located between 40 and 55 feet below the base of the Glenwood Formation. Although the tunnel alignment in bedrock has not been explored specifically for this study, sufficient data are available to allow problems to be identified and reliable cost estimates to be made. The St. Peter Formation has been tunneled extensively in the Twin Cities area. A good description of the formation and tunneling characteristics developed from this experience is presented on Plate 3 of the reference cited in paragraph 11. The description is quoted in its entirety as follows:

The St. Peter Sandstone provides an optimum environment for low-cost tunneling and underground-space development. Except for a few thin, discontinuous shaly beds in its lower half, it is an exceptionally massive, homogeneous sandstone with little or no discernible bedding. Though weakly cemented the rock is well compacted. Cohesion is provided mainly by a small percentage of clay binder. The rock has good confined compressive strength and low to moderate compressibility, but it is friable and easily disaggregated. Pieces can be broken by hand, and the formation is commonly excavated rapidly by a water jet, which reduces the rock to a sand slurry removable by pipeline and slurry pump.

Many miles of unsupported utility and drainage tunnels have been constructed in the St. Peter Sandstone. Unsupported caverns 30 feet or more in width, which were excavated 50 to 100 years ago when the St. Peter Sandstone was mined for foundry and glass sand, still remain open.

Failure takes place gradually in underground openings in the sandstone through grain-by-grain raveling and crumbling of exposed surfaces. This process is most rapid in zones of tensional stress in the crowns of openings. Over a period of time, the crowns of tunnels assume a "gothic arch" form or even a convexly curved "tented" profile. This process can be arrested by preventing skin decomposition. Research at the University of Minnesota (Nelson, 1977) has developed methods of arresting the skin decomposition by spraying. The rock is stabilized by impregnation with a chemical grout. Use of the technique makes the St. Peter Sandstone stable, and easily and rapidly excavatable by low-cost methods.

The principal problems with excavation in the sandstone relate to the occurrence of water, and to zones of diagenetic alteration in the clay binder. Both occur sporadically and are not predictable on the basis of existing information.

The St. Peter Sandstone generally has moderate permability (coefficient of permeability 3.5 to 6.6 x 10^{-3} cm/sec), and because the rock is sparsely jointed, water enters excavations mostly by slow seepage. Difficulties arise where joints are encountered below the water table or where the formation has been disturbed by nearby operations. Once free flow begins in a joint or disturbed zone the rock erodes rapidly and must be protected.

In some places illite, which is the primary clay binder in the rock, has been altered to kaolinite. The illite tends to adhere to sand grains and bind them together, but the secondary kaolinite forms discrete crystalline grains in spaces between sand grains (W. E. Parham, written commun., 1975) and cohesion is greatly reduced. Where this process is well-advanced the rock becomes an almost incoherent, free-running sand. Such conditions cannot be predicted because the geologic factors that control the formation

of kaolinite are not well-enough understood. Tunneling operations should include stand-by preparation for rapid breast-boarding to deal with this phenomenon. Chemical grouting probably can be used as a control.

20. The preceding discussion does not stress the fact that unlined tunnels must not be subjected to running water. Water control during construction is, therefore, very important. Also, prevention of leakage from or into completed tunnels is an important consideration and must be addressed in the tunnel design.

21. Problems in unwatering the sandstone were encountered by the Minnesota Department of Transportation in their 2nd Street tunnel, to which this tunnel will connect, due to shaly seams about 90 feet below the base of the Glenwood Formation. This material served as an aquitard which decreased the drawdown efficiency of the unwatering wells. A similar problem must, of course, be anticipated in the construction of the subject tunnel. Experience in the same tunnel showed that spraying the sandstone with sodium silicate immediately after exposure controlled raveling of the sandstone but that occasional treatment with rock bolts, mesh and shotcrete was required to control excessive overbreak at the crown of the tunnel.

22. GROUND WATER

The entire tunnel will be below the water table for which an approximate, or inferred, location is shown on the geologic profile along the tunnel alignment. Where bedrock is present, a perched body of water is expected on top of the Platteville Formation and the true water table is in the St. Peter Formation. Considerable refinement in the definition of the ground-water conditions and hydraulic properties of the materials will be necessary to allow final evaluation of the tunneling methods and unwatering effort required and the impact of this effort in areas susceptible to subsidence due to drawdown of the water table.

23. TUNNELING PROCEDURE

Options available for tunneling in the overburden range from simple hand mining in a shield with temporary ring-beam and lagging support followed by casting a permanent liner in place to tunneling with compressed air to control ground water and improve ground stability with installation of a permanent liner as the tunnel progresses. Intermediate between the extremes are tunneling with a slurry shield, earth-pressure-balance shields or pipe jacking. Compressed air, slurry shields and possibly pipe jacking require little unwatering, require minimum ground modification and yield the least disturbance to overlying and adjacent features. They are, however, more complex and less common in the construction industry. The earth-pressure-balance and simpler shields generally require unwatering, require a greater amount of ground modification and produce greater disturbance to overlying and adjacent features. Additional data and evaluation are necessary to select the most cost-effective tunneling method; therefore, present plans and costs are based on tunneling with a rudimentary shield, maximum unwatering effort and significant ground modification. As more data become available in the feature design stage, tunneling procedures will be analyzed to

optimize the tunneling method with an appropriate design and disturbance restrictions.

24. A number of options are available for tunneling in the St. Peter Formation, but the method used extensively consists of simple mining with hydraulic jets and removal of muck by pumping. The method requires unwatering which is normally performed with deep wells. As long as such tunnels in the formation remain unwatered they require little stabilization until a permanent liner is installed. No improvement over this tunneling method is expected to evolve from more detailed study.

25. TUNNELING CONSIDERATIONS

The following discussion addresses problems and considerations identified from the interpreted subsurface conditions along the tunnel alignment from the intake structure to Sta. 66+50 where it joins the existing 2nd Street tunnel. The evaluation is based on tunneling in the overburden by jacking a shield followed by ring-beam and lagging support and tunneling in the sandstone by hydraulic jetting with stabilization limited to spraying the sandstone with sodium silicate supplemented by occasional rock bolts, mesh and shotcrete as needed.

26. The intake structure will be located 50 feet upstream from Sta. 0+00. It will penetrate about 20 feet of soft terrace clay and be founded in terrace sand. The soft clay will have to be stabilized with sheet piling and the water table will have to be drawn down at least 30 feet. No significant problems are anticipated.

27. From the intake structure to Sta. 2+50 the tunnel will be in terrace clay and sand. The tunnel is underlain by 15 to 20 feet of sand that rests on clay. Unwatering in the sand will require closely spaced wells due to the shallow depth of sand below the tunnel. Drainage from the clay will, however, be slow, and ground support problems and settlement due to lost ground are anticipated. At Sta. 1+70 the tunnel will pass 11 feet under an 86-inch masonry sanitary sewer. The soft clay between the sewer and tunnel precludes ground modification by grouting; therefore, structural support will be required.

28. From Sta. 2+50 to 7+50 the tunnel will be in terrace sand. Glacial clay rises in a downstream direction and intersects the tunnel at Sta. 7+50. The thinning of the sand will make unwatering increasingly difficult due to the decreasing depth of wells below the tunnel. The tunnel will be offset 10 feet horizontally from buildings at Sta. 3+25 and 6+90. Borings will be taken at each building to determine appropriate stabilization methods and required instrumentation. Based on interpreted conditions, the building at Sta. 6+90 may possibly be stabilized by chemical grouting in the terrace sand or compaction grouting in the clay. Sufficient sand is not indicated at Sta. 3+25 to allow treatment by chemical grouting. Structural support or ground retention may be the only positive solutions for the buildings and will be evaluated. The cost of stabilization must, of course, be weighed against that of no protection and repair of any damage. At Sta. 5+70 the tunnel passes 20 feet under two sewers, a 6-inch water main and utility lines. A tolerable settlement must be defined by the owners and appropriate stabilization incorporated in the design.

29. From Sta. 7+50 to 10+00 the tunnel will be in terrace sand and glacial clay. Unwatering will require closely spaced surface wells or unwatering from the tunnel itself. A 3.5° change in tunnel alignment occurs at Sta. 8+00.

30. From the tunnel intake to Sta. 10+00 the soft terrace clay will be subjected to drainage by unwatering the underlying sand. If sufficient drainage occurs, the clay will consolidate and settlement, or subsidence, at the surface will be evident. The amount of subsidence will depend on the permeability of the clay, the load on the clay, and the duration of the drainage. Available test data show that the clay layer has a saturated unit weight of 100 pcf and a voids ratio of 1.9. In the absence of other test data it is assumed that the permeability ranges from 10^{-6} to 10^{-7} cm/sec, the compression index (C_c) is 0.65, the coefficient of consolidation (C_v) is 0.0066 to 0.066 ft^2/day and that the 20-foot clay layer will drain only to the underlying sand layer. The period of unwatering during which consolidation can occur is estimated to be 18 months. Using these assumptions, subsidence of 1.1 to 3.4 inches is predicted to occur over the unwatered area during the construction of the tunnel. Additional settlement over the tunnel alignment will, of course, occur due to lost ground.

31. From Sta. 10+00 to 30+00 the tunnel will be in glacial sediments indicated by the existing data to be stiff clay. The need for little, if any, unwatering effort is indicated, and disturbance of the overlying strata and structures is not expected to be a significant problem. Additional borings are needed in this reach to confirm such an optimistic interpretation, therefore, tunnel cost estimates for this report are based on more difficult conditions. Between Sta. 14+50 and 19+00 the alignment is overlain by several utilities and adjacent to bridge piles. A more intensive restudy of as-built bridge drawings and utilities will be made to confirm that the tunnel can be completed without damage to these features. The tunnel will pass 10 feet horizontally from building corners at Sta. 22+40 and 23+50. Borings will, of course, be taken at each site to determine if stabilization is cost effective compared with repair of any damage. Known utilities overlie the tunnel at Sta. 20+80, 21+70, 25+75 and 28+30. Tunnel alignment changes of 1.5°, 4.5° and 4.0° occur at Sta. 15+00, 19+10 and 22+40, respectively.

32. From Sta. 30+00 to 50+00 the tunnel is still in glacial sediments; however, available data indicate the material is sandier and greater unwatering and support problems are anticipated. The tunnel will pass under railroad tracks between Sta. 30+80 and 33+00. Existing buildings and utilities downstream from 36+00 will be removed for highway construction prior to tunneling and will not present a problem. Existing data indicate the tunnel will be in soft terrace clay or will have a mixed face of glacial sand and soft terrace clay where it passes under a buried channel in the glacial sediments between Sta. 41+00 and 45+00. Unwatering and support problems are anticipated. An inlet for surface drainage will be constructed between Sta. 43+00 and 44+00. The structure will be in soft terrace sediments which will require unwatering and will require structural support for construction. The tunnel alignment changes 5° at Sta. 37+40 and 36° between Sta. 42+50 and 45+50. Site specific borings will be taken for the inlet and to better define the subsurface profile.

33. At Sta. 50+00 the tunnel will enter the St. Peter Sandstone. Problems with boulders and weathered rock are anticipated at this transition. Unwater-

ing and occasional minor support problems are anticipated in the sandstone, but no problems with surface settlement are anticipated due to the thick cover of bedrock. The tunnel alignment makes a 90 transition between Sta. 65+00 and the existing 2nd Street tunnel. Sufficient borings will be taken to determine the character of the sandstone for tunnel and unwatering design.

TUNNEL PONDING AREA

34. GENERAL

The plan view, sections, and boring logs are shown on Sheets 10 and 11. Four borings were taken in the area, showing 10 to 20 feet of dump fill comprised of bricks, pieces of concrete, glass and wood mixed with gritty sand and gravel underlain by up to 65 feet of very soft silty clay and organic silt. The existing ground surface is at about elevation 810 with 15 to 20-foot mounds of brick rubble scattered over a portion of the area. The borings indicate that the original ground surface in the area, before placement of the fill, ranged from elevation 793 to 799. The water table ranges from elevation 805 at the upstream end of the pond to elevation 803 at tunnel inlet. Since the tunnel inlet structure has a weir elevation at 799.0, the water table in the immediate vicinity of the creek in the ponding area will be permanently lowered. The berm area and old creek channel, north of the pond, will be filled with suitable sandy soil and slopes will be at 1V on 3H or flatter. There is one sanitary sewer crossing the ponding area: an 86-inch brick and stone arch crossing on the Currie Avenue alignment. The pipe would be exposed by excavation to elevation 799, therefore, the 86-inch conduit will be rerouted north of the pond.

35. DISPOSAL AREA

About 300,000 c.y. of material will be excavated from the ponding area, with the bulk of that material being coarse dump fill. About half of the excavated fill material will be placed in the disposal areas shown on Sheet 10. The remainder of the material will have to be disposed of in a satisfactory manner. While no hazardous wastes were identified in the boring logs, the nature of a dump fill area suggests that some polluted materials may be present. A more extensive investigation will be conducted to locate any hazardous materials, and a proper disposal area located for them, if any are found.

36. DROP INLET STRUCTURE

A concrete drop inlet structure 23 feet wide with a 6-foot drop, from elevation 805 to 799, will be constructed at the upstream end of the pond. Borings indicate that the bottom of the structure will be founded on about 35 feet of soft silty clay. Settlement is not considered a problem because 20 feet of excavation will be needed to found the structure. However, bearing piles may be needed beneath the structure because of the low bearing capacity of the soft clay.

PENN AVENUE CULVERT REMOVAL

37. GENERAL

The existing 125-foot long box culvert, approximately 18' x 7', will be removed and replaced with an open channel having a 36-foot bottom width and 1V on 3H slopes. Boring 80-32M indicates that there is about 10 feet of loose to medium dense sand and gravel underlain by over 45 feet of very soft clay. The channel excavation will be very close to Pier No. 3 of the Penn Avenue Bridge, which is on timber bearing piles. The estimated velocities will be less than 3 fps in this area, even during high water levels, and therefore, no erosion should occur. However, to assure that Pier No. 3 is never undercut, a 55-foot section of riprap will be placed as shown on Sheet 14.

FRUEN MILL

38. GENERAL

Proposed improvements in the Fruen Mill area include: widening and re-alignment of the channel, replacement of the existing stone dam, and replacement of the timber MN & S Railroad bridge. The plan and sections are shown on Sheets 15 through 19. The existing channel will be enlarged to a 30-foot bottom width below the proposed spillway. In addition, the channel will be realigned away from the failing timber retaining wall alongside Glenwood-Inglewood's water plant, with riprap-covered pervious fill forming the left bank of the channel. Due to steep slopes and constraints involved with realigning the MN & S Railroad tracks, a sheet pile retaining wall was used to form the right bank of the channel from below the concrete spillway to 125 feet below the replacement railroad bridge.

39. The existing stone dam has a crest length of 25 feet and is so badly deteriorated that repair and widening of the structure is considered impractical. A concrete spillway with a crest length of 30 feet and a 5.6-foot difference in elevation between the spillway crest and stilling basin floor will be constructed to replace the stone dam. The existing timber railroad bridge supported by timber piles will be removed and replaced with a structure located upstream of existing bridge. The new structure will be constructed with only one center pier in the channel, eliminating the obstructions created by the existing bridge's many timber piles.

40. Soil borings taken in the Fruen Mill area are shown on Plate C-12. Soil test data taken to determine the allowable railroad bridge pile loadings is shown on Plates C-19 through C-21.

HIGHWAY 55 CONTROL STRUCTURE

41. GENERAL

The plan of the Highway 55 Control Structure, sections and boring logs are shown on Sheet 20. Two borings were taken in the area; 79-11M about 90

feet from the structure and 80-42M, within 10 feet of the structure. The borings show that there is a layer of soft to medium stiff clay and loose silt underlying a layer of sandy fill. A 28-foot long by 18-foot wide concrete structure will be added to the existing 8-foot by 10-foot double box culverts.

42. BEARING CAPACITY

Despite the soft layer of soil underlying the proposed control structure, bearing capacity is not considered to be a problem for this structure. Using boring 80-42M to obtain representative undisturbed samples, it was found that cohesive strengths from unconsolidated-undrained tests ranged from 800 to 1200 psf. Using the bearing capacity formula for a saturated clay ($q=NcC$) and an average cohesive value of 800 psf, the ultimate bearing capacity is estimated to be 4000 psf. The loading applied to the ground from the construction of the control structure is only about 500 psf so that the factor of safety against bearing capacity failure is around 8.0.

43. SETTLEMENT

Although soft, compressible soils underlie the proposed control structure, it is anticipated that very little settlement will occur. Consolidation tests were conducted on 2 undisturbed samples from boring 80-42MU. One test was on a sandy clay and the other on a loose silt. The test results indicate both materials are overconsolidated. Using the Boussinesq method of reduction of stresses with depth for the 500 psf structure load, the resulting pressure applied to these compressible layers is less than the preconsolidation pressure. Assuming that the compressible layers extend from the bottom of the structure to a depth of 35 feet, a total settlement of less than 1 inch was calculated for the reloading caused by the structure.

HIGHWAY 100 EMBANKMENT

44. GENERAL

The plan, section views and boring locations of the Highway 100 embankment are shown on Sheets 23 through 27. A total of 18 borings were taken near this site, 16 by Barr Engineering Company and 2 by the Corps. The boring logs are shown on Plate C-13. The borings show that a thick layer of swamp deposits will underlie a major portion of the embankment. These organic swamp deposits are very soft and susceptible to significant amounts of primary and secondary consolidation. Underlying these soft deposits, at depths ranging from 10 to 48 feet, are medium dense sandy outwashes and in some areas a medium dense glacial till. The borings show that the critical portion of the embankment is from Sta. 6+00 to 14+00 where the swamp deposits are thickest. The alignment chosen will minimize the amount of construction over the swamp deposits and maximize the number of homes given 100-year protection while inducing the least amount of damage to private property in the area.

45. EMBANKMENT DESIGN

For design purposes the embankment is divided into 3 sections: Sta. 1+00 to 4+75, Sta. 4+75 to 5+60 and Sta. 5+60 to 14+43. Sta. 0+00 to 1+00 is a small road raise with a 30-foot top width. Between Sta. 0+00 and 4+75 the embankment is designed to contain the 100-year flood and overtop for larger floods. Following overtopping in this reach, the tailwater will rise rapidly and the remainder of the embankment will overtop at 851.5 with no significant head differential; consequently, there will be no danger from catastrophic failure to the homes immediately downstream of this section. The total embankment will overtop only for floods less frequent than the 500-year flood.

46. Sta. 1+00 to 4+75 has a top width of 20 feet, an upstream slope of 1V on 3H and a downstream slope of 1V on 6H from the top to elevation 847.0 then 1V on 3H from 847.0 to the ground surface. The ultimate top elevation after 100 years of secondary consolidation will be 851.0. Therefore, a 0.3-foot overbuild will be added to give a 851.3 top elevation at the end of construction. The relatively thin peat layer at the ground surface, as shown in boring BC-4M, will be excavated and replaced with adequate fill before construction. The embankment will be constructed of pervious fill to elevation 847.0, with 1V on 3H slopes. On top of this an erosion resistant clay having a liquid limit greater than 30 and a plasticity index greater than 15 will be placed to the top elevation and slopes described above. The clay fill and flat downstream slope are required in this reach because when the embankment overtops, there will be a 2.1-foot head differential. This overtopping will occur for only a matter of hours and the tailwater will rise very rapidly. By the time the headwater gets to elevation 851.5, the tailwater will have risen to the same elevation. This is not classified as a high hazard dam, therefore, the clay-capped embankment with flat slopes is considered adequate to withstand the overtopping differential for the limited time it will occur.

47. Sta. 4+75 to 5+60 is a road raise for Medicine Lake Road with a 30-foot top width, a top elevation of 851.5 and maximum grades of 5 percent. All soft sediments in this area will be excavated and backfilled with compacted pervious fill to assure no settlement beneath utilities under road. Side slopes will be 1V on 3H and all embankment fill will be pervious.

48. Sta. 5+60 to 14+43 will be constructed in 3 stages due to the large predicted settlements and the low unconsolidated, undrained strengths of the soft foundation soils. The first stage will be constructed in compacted layers to elevation 850 and allowed to consolidate for 12 months before Stage II construction begins. Stage III construction will begin 12 months after Stage II has been completed. Stage III construction will have a 20-foot top width and a top elevation of 856.6 that includes 5.1 feet of overbuild. Since large amounts of settlements will occur, the slopes will be continually changing. Therefore, the slope after Stage III construction will range from 1V on 3H to 1V on 4.75H upstream and 1V on 3.7H to 1V on 6H downstream. The embankment will be constructed of pervious fill; therefore, an inspection trench is considered unnecessary. This portion of the embankment will be overtopped at something less than the Standard Project Flood. The overtopping will occur with no head differential; consequently

little or no damage to the embankment should occur. See Sheets 24 through 26 for staged construction and typical sections.

49. STABILITY

Sta. 8+25 was chosen as the critical section for stability because boring BC-4E showed the thickest layer of soft sediments. This embankment will pond water for short periods of time minimizing the chance that steady state seepage through the embankment will occur. However, since pervious fill is being used, it was conservatively assumed that steady seepage would develop. Therefore, all conditions of stability discussed in EM 1110-1-1902 were analyzed.

50. The soft foundation sediments were divided into 3 separate types: peat, muck (OH-Pt), and organic silt (ML-OL). See the geologic profile on Sheet 23. All sampling, testing and classification for this site was done by Barr Engineering. When summarizing strength parameters, the strength tests for the peat and muck samples were combined because the test results and index properties were similar. A total of 4 undisturbed samples in the peat-muck soil resulted in 3 Q, 1 S and 3 $\bar{R}$ tests being conducted in addition to 14 vane shear tests. The organic silt had only 1 undisturbed sample on which a Q and $\bar{R}$ test were run. No tests were conducted on borrow samples, but with a pervious fill section adequate values could be estimated. For a summary of the soil strength parameters, see the tabulations on Plates C-4 and C-5.

51. The Q tests and vane shear tests indicate that the peat-muck materials have an undrained compressive strength of about 200 psf, which is not adequate to support the 8 feet of embankment fill plus 10 additional feet needed to allow for settlement. Therefore, construction will be staged to allow consolidation from partial lifts and thereby allow increased undrained strengths to be used as defined by the R-test strength envelope and shown on Plate C-4. Plate C-1 shows the increased strengths used for each stage. In order to use increased Q strengths the soft foundation materials would have to reach equilibrium from the added load. It was assumed that increased strengths could be used when the foundation reached a minimum of 90% primary consolidation. Therefore, from consolidation tests on this material, the time between stages was estimated to be 12 months, making the total time from Stage I to the end of Stage III greater than 2 years. This time could be greatly reduced if a system of vertical drains was installed in the soft soils beneath the embankment between Sta. 5+60 and 14+43 to speed up the consolidation process. Using the increased strength parameters and embankment sections for each stage as shown on Sheet 25, the minimum safety factor of 1.3 for the end of construction condition is satisfied for each stage. By applying a seismic loading coefficient of 0.025 to each of these cases, the earthquake factor of safety is also satisfied.

52. Because the embankment is being constructed of pervious fill, and while it is very unlikely, there is a possibility that high reservoir pools could stay up for a long enough duration to establish steady state seepage through the embankment. The section chosen for Cases II, IV and VI stability analysis has a top elevation of 854.4, a 1V on 3.45H upstream slope and a 1V on 4.4H downstream slope. This represents the embankment at the end of primary

consolidation which will occur about 1 year after Stage III construction. Secondary consolidation of the foundation will eventually flatten the side slopes to about 1V on 4.7H upstream and about 1V on 6H downstream. Thus the slope stability safety factors will increase with time. The sudden drawdown from maximum pool condition for water levels of 851.0 to 843.5 gives a safety factor just slightly greater than the required 1.0, but this is partly because a conservative ϕ' value of 30° was used for the embankment fill. If a ϕ' of 35° were used, a factor of safety of 1.26 would be achieved by the infinite slope formula. The minimum factor of safety is also for a failure arc almost tangent to the slope, which would cause no danger to the integrity of the embankment.

53. The partial pool and steady seepage with maximum pool conditions satisfy the required safety factors. The sudden drawdown from spillway crest and steady seepage with surcharge pool were not considered applicable for this embankment. Table 3 shows the required factors of safety and calculated factors of safety for each stability case. The stability analyses are presented on Plates C-1 to C-3.

TABLE 3

STABILITY AT STATION 8+25

Case	Design Condition	Minimum Required Factor of Safety	Minimum Calculated Factor of Safety
I	End of Construction		
	- Stage I	1.3	1.35
	- Stage II	1.3	1.44
	- Stage III	1.3	1.47
II	Sudden Drawdown from Maximum Pool	1.0	1.04
III	Sudden Drawdown from Spillway Crest	1.2	N/A
IV	Partial Pool with Steady Seepage	1.5	1.79
V	Steady Seepage with Surcharge Pool	1.4	N/A
VI	Steady Seepage with Maximum Pool	1.5	1.54
VII	Earthquake		
	- End of Construction		
	-- Stage I	1.0	1.08
	-- Stage II	1.0	1.22
	-- Stage III	1.0	1.29
	- Partial Pool	1.0	1.45
	- Steady Seepage	1.0	1.48

54. SETTLEMENT

The embankment is divided into 3 sections for settlement calculations: Sta. 1+00 to 3+50, Sta. 3+50 to 5+50, and Sta. 5+50 to 14+43. The foundation at Sta. 1+00 to 3+50, according to boring BC-4M, consists of 2 layers of soft sediments, separated by a layer of loose sand. Underlying the soft soils is a medium dense sand. The upper soft layer, about 5 feet thick, will be excavated and backfilled with pervious fill. This will leave a maximum compressible layer of 16 feet at a depth of about 15 feet. Settlement calculations show that with the average 6-foot height embankment, a maximum settlement of less than 0.5 feet will occur and of this 0.3 feet will be secondary consolidation during the next 100 years.

55. From Sta. 3+50 to 5+50, soft sediments will be excavated down to the medium dense sand or till and backfilled with compacted pervious fill to assure adequate stability and negligible settlement for the control structure, conduits and sanitary sewer and water main beneath Medicine Lake Road. The maximum excavation depth in this area is 17 feet.

56. From Sta. 5+50 to 14+43 the foundation consists of 25 to 47 feet of very soft organic sediments underlain by medium dense sand. Boring BC-4E shows the thickest layer of soft soil and boring BC-4C shows an average thickness. Based on consolidation tests and an embankment height of 8 feet plus 10 feet of overbuild, the dam was estimated to have the following settlements:

TABLE 4

SUMMARY OF TOTAL SETTLEMENT AT STA. 8+25 AND STA. 11+25

Boring BC-4 (maximum thickness)

Foundation Material	Thickness (ft)	Primary Settlement (ft)	Secondary* Settlement (ft)	
Peat	7	1.9	0.6	
Muck (OH-Pt)	29	4.6	2.8	
Organic Silt	11	0.1	0.0	
		6.6	3.4	Total=10.0 ft.

Boring BC-4C (average thickness)

Foundation Material	Thickness (ft)	Primary Settlement (ft)	Secondary* Settlement (ft)	
Peat	7	1.7	0.6	
Muck (OH-Pt)	21	4.7	2.1	
Organic Silt	-	-	-	
		6.4	2.7	Total=9.1 ft.

*Secondary Consolidation computed over 100-year period.

57. This section of the embankment extends mostly across an open park area; therefore, the large settlements should not cause problems to nearby structures or utilities. The closest structure is a sanitary sewer manhole about 130 feet from the downstream toe near Sta 13+00.

58. CONTROL STRUCTURE AND OUTLET WORKS

The peat and organic silt will be excavated down to the medium dense sand at the control structure to minimize potential differential settlement. The area will be excavated to elevation 827+ and immediately backfilled with compacted pervious fill to elevation 836.5 which is the base of the control structure. See Sheet 26 for sections through this area.

59. EXISTING UNDERGROUND UTILITIES

The existing vitrified clay pipe (VCP) under Medicine Lake Road will not withstand the additional load from the new embankment. The soft soils would also be susceptible to settlement. Therefore, the soft foundation soils will be removed from beneath the road and replaced with compacted pervious fill. The VCP pipe will be replaced with polyvinyl chloride pipe (PVC). The existing 8-inch cast iron pipe will not require replacement because of its higher crushing strength characteristics.

60. INSTRUMENTATION

Settlement plates will be installed in the area of Sta. 5+60 to 14+43 to measure the amounts of settlement beneath the embankment to compare with estimated amounts. Scheduled periodic surveys will monitor the embankment crest to assure that the required top elevation is maintained.

GOLDEN VALLEY COUNTRY CLUB EMBANKMENT

61. GENERAL

The plan and section views and boring logs of the Golden Valley Country Club embankment are shown on Sheets 29 through 30. Four borings were taken at this site, with 3 (80-23M, 80-24M, and 80-25M) located up to 95 feet downstream of the overflow structure. These borings, taken for a different alignment, show alternating layers of medium stiff and medium dense fine- and coarse-grained alluvium underlain by loose to medium dense sand to a depth of over 50 feet. Boring 75-1M, taken just upstream of the structure, shows soft to medium stiff fine-grained soils in the top 8 to 10 feet, with medium dense sand below.

62. EMBANKMENT DESIGN

The earth embankment is notched to allow necessary controlled overtopping to occur when water levels rise above the 100-year frequency flood level. The maximum head differential across the embankment that will occur during overtopping is about 2.1 feet. The flood flows will decrease rapidly and the overtopping condition will exist for only a matter of hours. Although designing an earth dam for differential overtopping is not standard design practice, it is considered necessary and acceptable for this embankment.

63. The top of the main portion of the embankment is at elevation 877.0 with 1V on 10H slopes down to the bottom of a 45-foot wide notch at elevation 874.5 (approximate 100-year flood level), which is centered over the twin

box culverts. The notched section of the embankment is designed to withstand overtopping by keying a 5-foot wide by 70-foot long concrete slab at the dam crest into the impervious embankment fill to act as a fixed overflow weir. Beneath this slab and extending along the downstream slope, 12 inches below the ultimate embankment surface, is a 12-inch layer of riprap on 6 inches of bedding and covered with $3^{\pm}$ inches of lean concrete. The concrete covered riprap extends down to where it either intersects the 33-inch riprap layer of the stilling basin at elevation 868.5, or to a depth of 3 feet below the existing ground surface. The riprap protection is buried for aesthetic reasons, with the whole embankment except the concrete crest slab covered with topsoil and seeded. If the soil above the riprap erodes during overtopping the rough concrete surface covering the riprap would provide better embankment protection than the riprap alone. To retard the loss of soil upon overtopping, the zone above the concrete-covered riprap will be constructed of an erosion-resistant clay that has a liquid limit greater than 30 and a plasticity index greater than 15.

64. The embankment has a top width of 10 feet at elevation 877.0 and a maximum height of less than 6 feet. The width across the notch at elevation 874.5 is 30 feet. The upstream slope is 1V on 4H from the top of the dam to elevation 870.0 where the slope changes to 1V on 2½H. The downstream slope is 1V on 4H from the top of the dam to elevation 866.4, which is the culvert invert elevation and the point where the slope changes to 1V on 2½H. The relatively flat side slopes were chosen to blend the embankment into the surrounding golf course terrain. The existing ground surface will be stripped to a depth of 6 inches beneath the embankment.

65. Any soft sediments encountered in the excavation for the two 4-foot by 6-foot concrete box culverts will be removed and replaced with suitable backfill.

66. STABILITY

Under normal conditions, the flow through the box culverts will be uncontrolled. High flood levels will occur only for short durations, not allowing the embankment to saturate or establish a phreatic surface through the embankment. Therefore, the only stability conditions that have to be analyzed are the end of construction case and a long-term stability case with no line of seepage through the embankment. The only testing done on undisturbed foundation soil samples were from boring 80-24M, 95 feet downstream of the structure. The following is a tabulation of strength parameters obtained from testing.

TABLE 5

TABULATION OF STRENGTH PARAMETERS

Boring	Depth (ft)	Class	Test	C (tsf)	Ø (deg)	Ø' (deg)
80-24M	11-12.5	SM-SC	Q	2.48	0	-
80-24M	11-12.5	SM-SC	$\bar{R}$	1.20	32.5	36.5
80-24M	13.6-15.0	CL	Q	2.62	0	-
Values Obtained from Edgewood Borrow Test Results			Q	0.38	10	-
			R	0.20	10	-
			S	-	-	31

67. For any condition of stability that needs to be analyzed, the factor of safety requirements are more than satisfied because of the high soil strength parameters, the relatively flat side slopes and the small height of the embankment. For this reason, a stability analysis plate for the embankment is not included in the report.

68. SETTLEMENT

Much of the foundation material is dense, coarse-grained soil and not susceptible to consolidation under the light loads being applied. There are small layers of medium stiff clay shown in borings 80-23M, 80-24M and 80-25M, but not enough to result in any measurable amounts of settlement. Boring 75-1M shows 5 to 8 feet of soft to medium stiff compressible material near the ground surface; however, since the embankment fill height ranges from only 3 to 5.5 feet above the ground surface, negligible settlement should occur. Small settlements under this embankment are acceptable, except beneath the fixed 45-foot long overflow weir and twin box culverts which pass under the weir section. Any soft sediments encountered beneath the concrete weir and twin box culverts will be excavated and replaced with suitable material to minimize settlement.

69. SEEPAGE CONTROL

Borings indicate that in general the foundation soils are pervious below the upper 5 to 10 feet. The maximum pool differential across the embankment is about 2.1 feet, and this occurs for only a short duration; therefore, seepage through the foundation is not a problem.

70. Under normal conditions this embankment will not pond water behind it. When high flood levels occur, there will be insufficient time to create steady seepage through the impervious-fill embankment. Therefore, seepage through the embankment will not be a problem.

WISCONSIN AVENUE EMBANKMENT

71. GENERAL

The plan, profile, sections and boring logs are shown on Sheets 31 through 32. Two soil borings were taken at the structure location indicating that up to 7 feet of soft swamp deposits are underlain by about 16 feet of medium dense sand and very stiff till. A thin layer of fill overlies the swamp deposits. The embankment, which will be constructed by the City of Golden Valley, will have a roadway crest width of 58 feet and a maximum height of 10 feet. The total length of roadway will be 1400 feet with 650 feet in a cut area and about 750 feet in a fill area. Little soils exploration or testing was done at this time because the final alignment is subject to change by the city. The control structure consists of a drop inlet with a 20-foot long weir attached to a 6' x 8' precast concrete box culvert and apron.

72. STABILITY

No test data were obtained from the borings, but using assumed values and test results from similar soils at the Highway 100 embankment, a stability analysis was completed. The following is a summary of strength parameters used for the analysis.

TABLE 6

TABULATION OF STRENGTH PARAMETERS

Soil Type	Q		R		S		γ_{sat}
	C (psf)	Ø	C (psf)	Ø	C (psf)	Ø'	(pcf)
Embankment Fill*	-	-	-	-	0	30	130
Peat**	240	0	400	17	-	-	72
Foundation Sand*	-	-	-	-	0	30	130

*Assmued Values
**From Highway 100 Embankment test results

73. The use of low undrained strengths for the soft organic layer required that 1V on 4H slopes be used to achieve an adequate factor of safety for the End of Construction condition. The Partial Pool and Sudden Drawdown conditions were not considered applicable because of the short duration of high water levels. The following is a tabulation of required and existing factors of safety for applicable stability cases.

TABLE 7

STABILITY AT STA. 10+00 USING 1V ON 4H SLOPES

Case	Design Condition	Minimum Required Factor of Safety	Minimum Calculated Factor of Safety
I	End of Construction	1.3	1.34
VI	Steady Seepage from Maximum Pool	1.5	1.72
-	Infinite Slope - No Seepage	-	2.3

74. If future exploration along the embankment alignment shows that the maximum depth of swamp deposits is no more than 7 feet, it would be recommended that the soft materials be excavated and replaced with adequate backfill. This would allow the embankment slopes to be steepened to about 1V on 2½H while still meeting stability requirements. This would also eliminate any problems with differential settlement due to varying thicknesses of soft, compressible soils beneath the roadway. In any event, the soft soils will be excavated from beneath the control structure and replaced with suitable backfill before constructing the drop inlet and placing the box culvert.

75. WINNETKA AVENUE RETENTION DIKE

The storage pool ponded by the Wisconsin Avenue embankment requires that a retention dike be placed along the west side of Winnetka Avenue, and a 24-inch CMP culvert be jacked beneath the road. The dike will be 540 feet long with a top elevation of 890, a 10-foot top width and 1V on 3H slopes. The maximum height of fill along the centerline of the dike will only be about 4 feet. However, this area is swampy and soft, compressible deposits are expected to underlie the proposed dike which could result in unacceptable amounts of settlement beneath the culvert. Soils investigation will be conducted before the Plans and Specifications phase to assure that there is an adequate design in this area.

MEDICINE LAKE OUTLET STRUCTURE

76. GENERAL

The plan view and sections are shown on Sheet 33. The boring logs are shown on Plate C-14. The borings in this area indicate 15 to 27 feet of soft, organic soils underlain by a stiff clay and dense sandy till. Initial plans called for a 1:3-foot long overflow earth embankment in this area. However, because of the highly compressible soils having poor compressive strengths and the erodible qualities of earth fill, it was decided that a sheetpile structure would cause fewer problems and be a better alternative. The proposed three-sided outlet structure consists of sheetpile driven to an adequate depth to allow ponding of less than 3 feet of water upstream of

the structure. Using boring 80-28M, the length of pile required is only 22 feet. Twelve inches of riprap and 6 inches of bedding will be placed inside the outlet structure to prevent erosion of materials during overtopping. The control structure will be embedded in the railroad embankment, and the slope of the embankment will be flattened to 1V on 2H with clay fill, topsoiled and seeded inside the structure. The structure will have a 13-foot low flow section at elevation 887.1 and a 150-foot long overflow weir at elevation 889.1. The 15-foot section of piles connecting the structure to the railroad embankment will have a top elevation of 892.1. The capacity of the existing opening in the railroad embankment will be increased by driving vertical piles at each abutment and placing concrete across the bottom of the channel.

77. Upstream of South Shore Drive an existing control structure will be removed and the channel will be widened with 20-foot steel sheetpiles driven to form the vertical sides of the channel. The top of the piles will be level with the existing ground surface (elevation 890±) and the bottom of the channel will be at 885.0.

EDGEWOOD EMBANKMENT

78. GENERAL

The plan and section views of the Edgewood embankment are shown on Sheets 37 through 38. Barr Engineering Company took 7 borings at the dam site and 8 more in the proposed reservoir. Three USCE borings were taken at the dam site and 2 in the reservoir area. The embankment borings show that the foundation consists of stiff to very stiff clay till and silt and is underlain by very dense sand at a depth of about 40 feet. The reservoir borings were taken to identify soils suitable for use as borrow in the construction of the Edgewood and Golden Valley Country Club embankments. These borings show that the borrow is a sandy clay till that will have relatively high remolded strength. The borings are shown on Plate C-16.

79. EMBANKMENT DESIGN

This embankment is designed to be overtopped at floods greater than the 100-year level without subsequent failure due to erosion of the downstream slope. The standard project flood (SPF) and probable maximum flood (PMF) will overtop the embankment with a maximum differential between headwater and tailwater of 11 feet. However, the duration of overtopping is very short with the SPF lasting about 1 hour and the PMF about 6 hours. Velocities during overtopping exceed 17 fps and a hydraulic jump will occur on the downstream slope. The embankment is classified as a high hazard structure and is designed to be stable for the PMF.

80. The earth embankment will have a top width of 20 feet, an average height of about 10 feet and a 1V on 3H upstream slope. Across the top and down the downstream slope, buried under 15 inches of soil, will be 12-inch rockfilled gabion baskets on 6 inches of bedding. The baskets will be covered with 3 inches of concrete to provide greater erosion protection

during overtopping. From Sta. 0+10 to Sta. 0+80 the gabions are placed at a 1V on 4H slope down to the existing ground surface and are then buried 5 feet at a 1V on $2\frac{1}{2}$H slope. From Sta. 0+80 to Sta. 1+66 the gabion baskets will be placed on a 1V on 4H slope to elevation 870 where the slope changes to 1V on $2\frac{1}{2}$H and extends to elevation 864.4. Between Sta. 1+66 and Sta. 1+83 the slope is warped from 1V on 4H to 1V on 3H. The crest of the dam is at elevation 880.0, which is approximately the 100-year flood level, and extends from Sta. 0+28 to Sta. 1+66. At both ends of the embankment the gabion protection continues up the abutment at a 1V on 3H slope to elevation 886, which gives 3 feet of freeboard above the PMF.

81. For aesthetic reasons, the concrete-faced gabion baskets will be covered by 11 inches of compacted fill and 4 inches of seeded topsoil. To retard the loss of this soil during overtopping, an erosion resistant clay having a liquid limit greater than 30 and a plasticity index greater than 15 will be used as fill.

82. Four feet downstream of the embankment centerline, the gabion basket blanket will be interrupted by a concrete section extending from Sta. 0+19 to Sta. 1+75. The top of the concrete will be at the crest of the embankment and will act as a fixed overflow weir. To help maintain the top of the concrete weir at a permanent elevation, 8-foot long steel sheetpiling will be driven into the embankment and embedded into the concrete.

83. The main embankment will be constructed of compacted sandy clay fill obtained from the reservoir excavation upstream of the embankment. The existing ground surface will be stripped to a depth of 9 inches except where layers of organic materials exist at the surface, in which case excavation will be required to suitable material. An inspection trench will be excavated along the centerline to a depth of 6 feet.

84. STABILITY

The uncontrolled discharge outlet will allow reservoir pools to stay up for only short periods of time. Stage hydrographs show that reservoir pools above elevation 1070 stay up for periods ranging from 2 hours for the 100-year flood to about 8 hours for the PMF. Since the embankment will be constructed of impervious fill, there is no opportunity for saturation of the embankment or steady state seepage to occur in this short time span. Therefore, the sudden drawdown, partial pool and steady seepage conditions that require a long-term pool to establish a seepage line, as defined in EM 1110-2-1902, need not be analyzed for this embankment. The only applicable stability conditions to be analyzed are the end of construction case and a long-term stability case with no line of seepage through the embankment. A complete set of Q and R or $\bar{R}$ tests were conducted on each soil type to assure satisfactory stability because of the high hazard classification. Six undisturbed samples at the embankment site and 2 sack samples from the upstream borrow area were obtained. A total of 5 Q tests and 5 $\bar{R}$ tests were performed on the undisturbed samples. The sack samples resulted in 2 Q, 1 $\bar{R}$ and 2 R tests on remolded specimens. The following is a summary of strength parameters obtained from testing.

TABLE 8

TABULATION OF STRENGTH PARAMETERS

Soil Type	Q C(psf)	Q Ø	R C(psf)	R Ø	S (from R̄ tests) C(psf)	S (from R̄ tests) Ø'	γ_m (pcf)	γ_{sat} (pcf)
Embankment Fill	750	10	400	10	0	31	106	130
Foundation Clay	1500	0	400	22	0	30	134	138
Foundation Silt	2400	34	1600	35	0	39	131	131

See Plates C-6 to C-8 for strength plots and Plates C-32 to C-39 for individual test results.

85. Using these parameters, a stability analysis for the end of construction and long-term stability condition was conducted at Sta. 0+90, which was determined to be the most critical section. A minimum factor of safety greater than 8.0 was obtained for the end of construction condition, reflecting the very stiff composition of the foundation materials. The long-term stability condition was analyzed with a full pool at elevation 880 on the upstream side, and a tailwater and phreatic surface through the embankment at elevation 870, resulting in a minimum factor of safety greater than 2.4. Both of these minimum safety factors are much greater than the required values, therefore, stability sections were not drawn up for this embankment. A check of embankment stability due to a long-term pool at elevation 880, establishing steady state seepage at the downstream toe, gives a minimum factor of safety greater than 1.8. While this condition is very improbable and not possible under normal situations, the safety factor is significantly greater than the 1.4 which is required. The following is a tabulation of required and existing factors of safety for each stability case.

TABLE 9

STABILITY AT STATION 0+90

Case	Design Condition	Minimum Required Factor of Safety	Minimum Calculated Factor of Safety
I	End of Construction	1.3	8.3
II-V	Sudden Drawdown, Partial Pool, Steady Seepage from Maximum Pool	1.0-1.5	N/A
VI	Steady Seepage from Surcharge Pool	1.4	1.8
VII	Earthquake		
	- End of Construction	1.0	9.1
	- Partial Pool	1.0	-
	- Steady Seepage from Maximum Pool	1.0	-
-	Maximum Pool with No Phreatic Surface	-	2.4

86. SETTLEMENT

The foundation consists of about 35 feet of stiff to very stiff clayey till and silt underlain by very dense sand. Borings BC-10D, BC-15D, and 81-57M, near the outlet conduit, show mostly silt and very little clay in this area. Two undisturbed silt samples from 81-57M and 1 clay sample from BC-15D were used for consolidation tests in this area. The silt samples proved to be just slightly compressible for the loads applied. Because the conduit will be placed beneath the existing ground surface and because the embankment is only 10 feet in height, there will be very little increase in foundation stress. Therefore, negligible settlement will occur beneath the conduit. At Sta. 0+90, near borings BC-10C and 81-58M, the foundation consists of mostly clay with very little silt to a depth of over 35 feet. Two undisturbed samples from 81-58M and 1 from BC-10C were used for consolidation tests in this area. The tests showed that the clay samples were overconsolidated so that with the relatively small load applied to the foundation by the 10-foot embankment, a maximum total settlement of about 2 inches will occur. This small amount of settlement is acceptable in this portion of the embankment.

87. SEEPAGE CONTROL

The overall impervious nature of the foundation soils, the clay fill embankment with inspection trench and the very short duration of reservoir pool will preclude any seepage problems at this embankment.

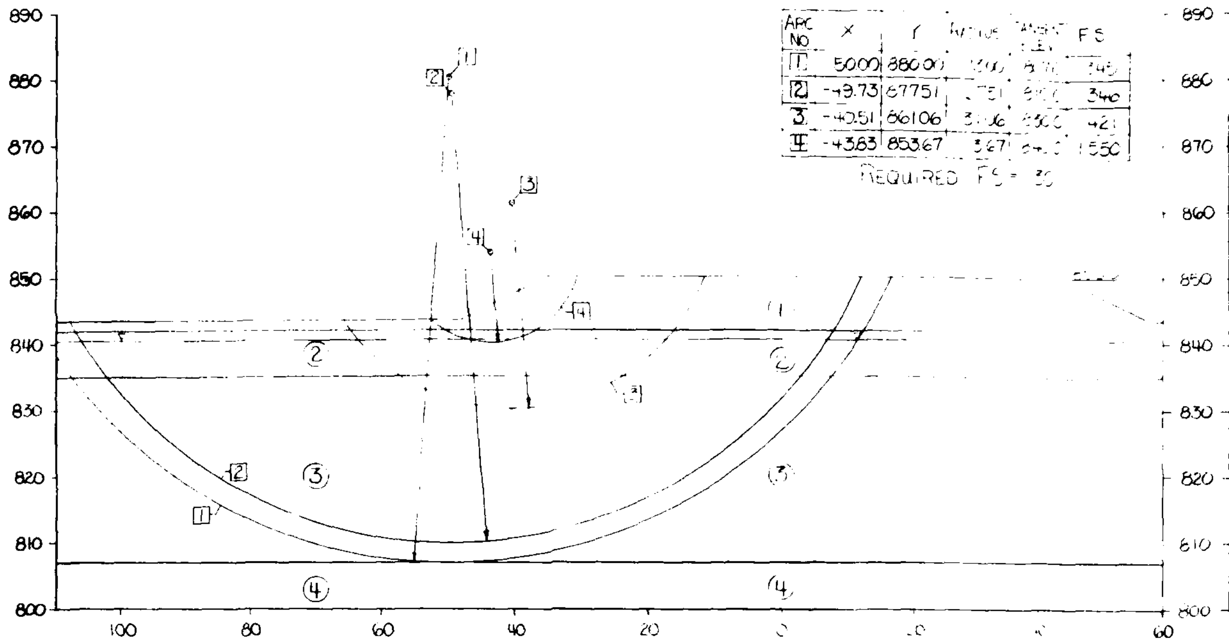
88. BORROW AREAS

Borrow for this embankment and the Golden Valley Country Club embankment will come from the reservoir area upstream of the dam. The reservoir will be excavated as shown on Sheet 39 to achieve adequate flood storage and will have 1V on 3H or flatter slopes for all areas of excavation. Borings show that the excavated material is a very stiff sandy clay till, indicating that the reservoir slopes will be stable for the proposed cut slopes. A new low flow channel will be excavated from the Georgia Avenue culvert to the Edgewood embankment inlet. Riprap will be required for 60 feet downstream of the Georgia Avenue culvert and for 10 feet upstream of the embankment inlet.

CONSTRUCTION MATERIALS

89. RIPRAP AND CONCRETE AGGREGATE

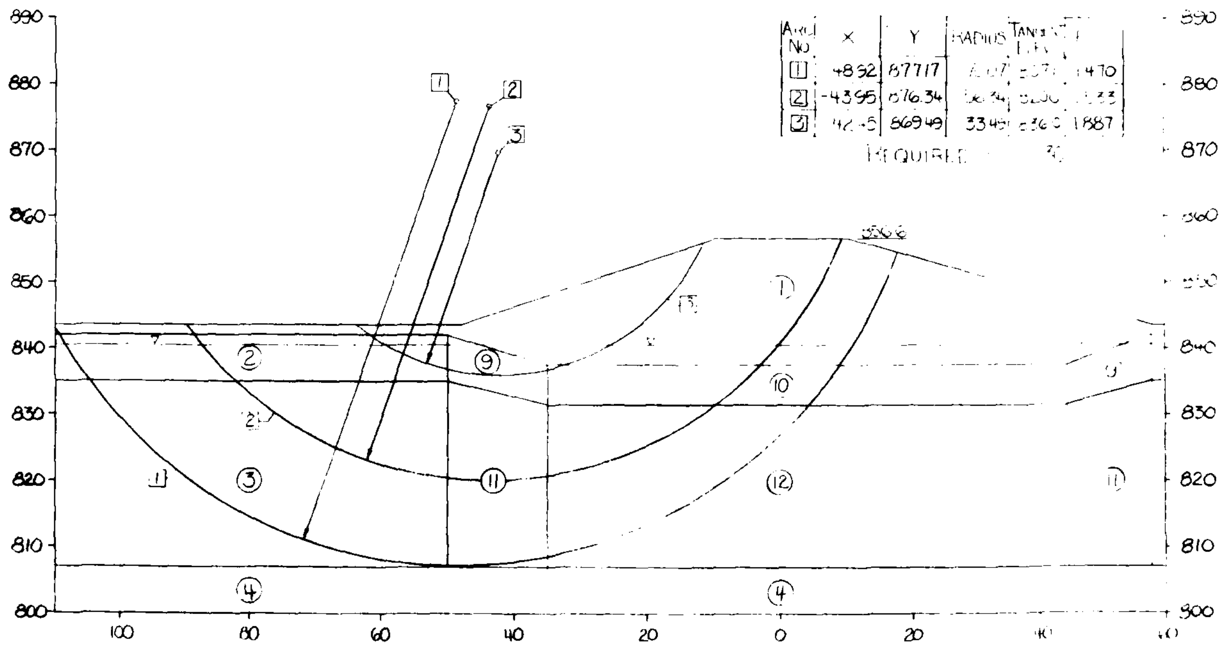
Riprap and concrete aggregate produced from several sources in the Twin Cities metropolitan area have been used successfully on numerous Corps of Engineers projects. No problems in obtaining adequate supplies of good quality material will be encountered.



ARC NO	X	Y	RADIUS	TANGENT ELEV	F S
1	50.00	880.00	[illegible]	[illegible]	[illegible]
2	-49.73	877.51	[illegible]	[illegible]	3.40
3	-40.51	861.06	[illegible]	[illegible]	4.21
4	-43.83	853.67	[illegible]	[illegible]	15.50

REQUIRED FS = [illegible]

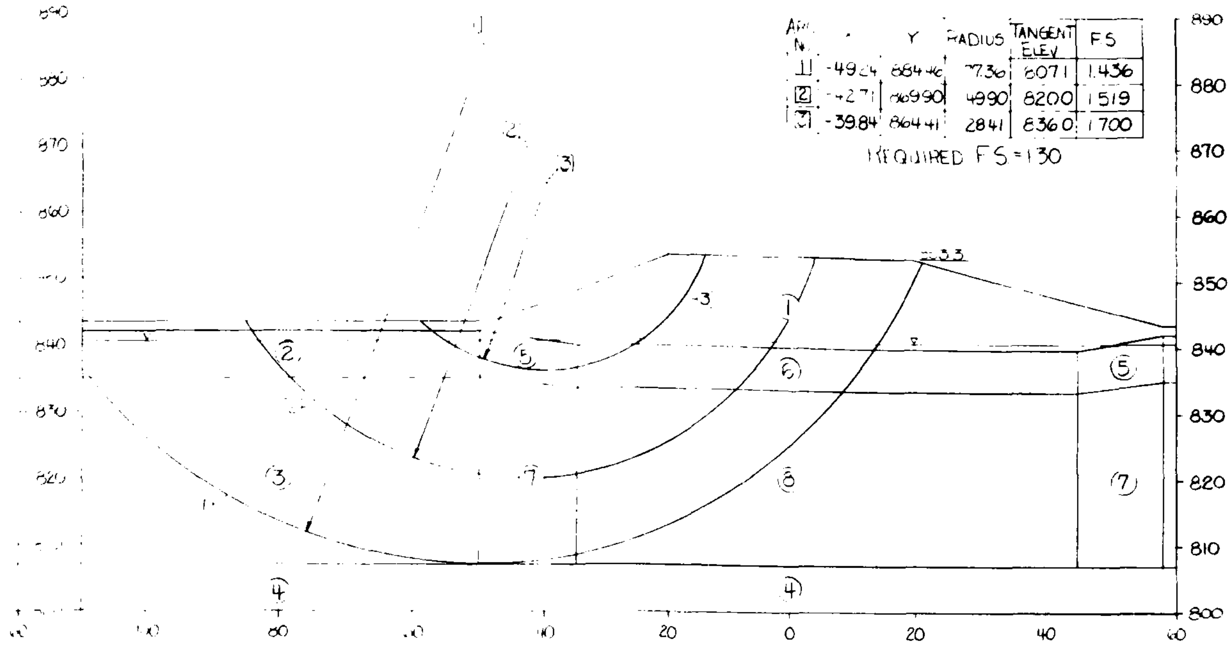
STAGE I - END OF CONSTRUCTION
STA 8+25



ARC NO	X	Y	RADIUS	TANGENT ELEV	F S
1	48.92	877.17	[illegible]	[illegible]	14.70
2	-43.95	876.34	[illegible]	[illegible]	[illegible]
3	[illegible]	869.49	33.49	[illegible]	18.87

REQUIRED [illegible]

STAGE III - END OF CONSTRUCTION
STA 8+25



ARC No.	X	Y	RADIUS	TANGENT ELEV	FS
1	-49.24	884.46	77.36	807.1	1.436
2	-42.71	869.90	49.90	820.0	1.519
3	-39.84	864.41	28.41	836.0	1.700

REQUIRED FS = 1.30

STAGE II END OF CONSTRUCTION
STA 5+25

	No	MATERIAL TYPE	γ_m (PCF)	γ_{SAT} (PCF)	Q STRENGTHS C (PSF)	Q STRENGTHS ϕ (DEG)
STAGE I	1	PERVIOUS EMBANKMENT FILL	130.0	135.0	0	30
	2	UNCONSOLIDATED PEAT	65.0	67.0	200	0
	3	UNCONSOLIDATED MUCK (OR Pt)	75.0	75.0	200	0
	4	SILT (ML-OL)	124.0	124.0	0	22.5
STAGE II	5	PEAT [illegible] STAGE I [illegible]	65.0	67.0	250	0
	6	PEAT [illegible]	65.0	67.0	400	0
	7	MUCK [illegible]	75.0	75.0	300	0
	8	MUCK [illegible]	[illegible]	[illegible]	450	0
STAGE III	9	PEAT [illegible] STAGE II [illegible]	[illegible]	[illegible]	470	0
	10	PEAT [illegible] STAGE II [illegible]	[illegible]	68.0	800	0
	11	MUCK [illegible] STAGE [illegible]	[illegible]	81.0	480	0
	12	MUCK [illegible] STAGE II [illegible]	81.0	81.0	850	0

NOTE: [illegible] STRENGTHS WERE [illegible] NORMAL STRESS [illegible] INCREASED [illegible] STRENGTH ENVELOPE [illegible] (SEE SHEET C-4)

SYMBOL	DESCRIPTION	DATE	APPROVAL

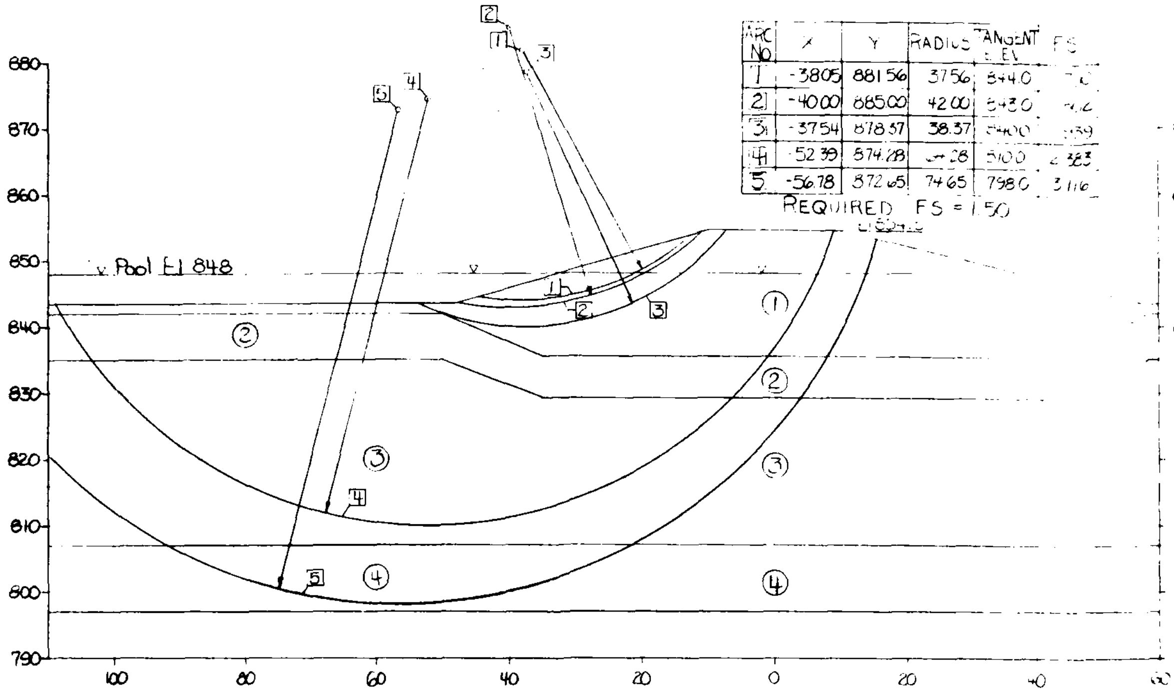
DESIGNED BY: D R
DRAWN BY: D R
CHECKED BY: M S
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

HIGHWAY 100
STABILITY ANALYSIS
END OF CONSTRUCTION CONDITIONS

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-5/229
SHEET C-1 OF C-39

2



ARC No	X	Y	RADIUS	TANGENT ELEV	FS
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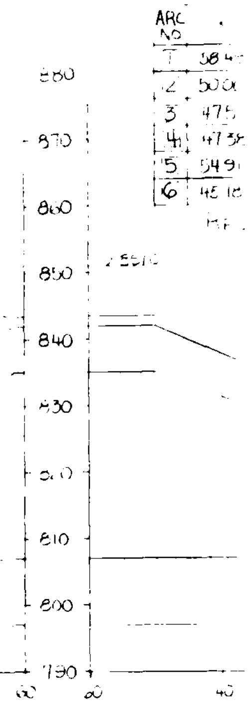
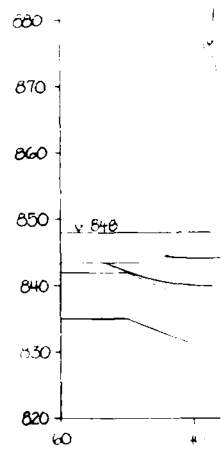
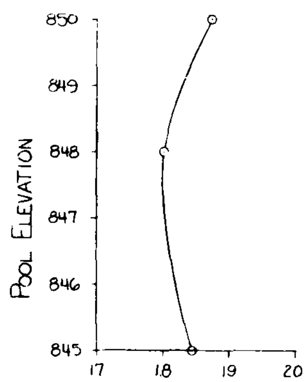
2	-40.00	885.00	42.00	843.0	[illegible]
3	-37.54	878.57	38.37	8400	[illegible]
4	-52.39	874.28	[illegible]	5100	[illegible]
5	-56.78	872.65	74.65	798.0	3.116

REQUIRED FS = 1.50

PARTIAL POOL AT END OF PRIMARY CONSOLIDATION
STA 8+25







FACTOR OF SAFETY
PARTIAL POOL ANALYSIS

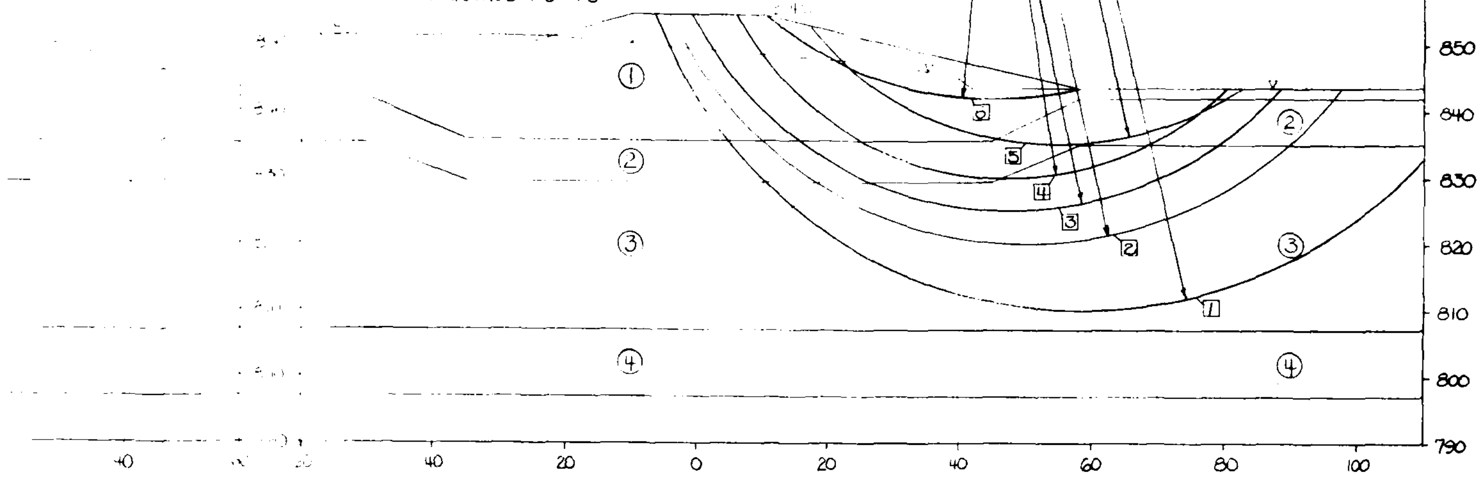
No	MATERIAL TYPE	S STRENGTH C (psf)	S STRENGTH Φ (DEG)	R STRENGTH C (psf)	R STRENGTH Φ (DEG)	(R+S)/2 C (psf)	(R+S)/2 Φ (DEG)	γ_m (pcf)	γ_{sat} (pcf)
(1)	EMBANKMENT FILL	0	30	0	30	0	30	130	135
(2)	PEAT	0	43.5	150	20.5	75	32	66	68
(3)	MUCK (OH-PT)	0	43.5	150	20.5	75	32	81	81
(4)	SILT (ML-OL)	0	40.5	200	38	100	39.3	124	124

RADIUS	TANGENT ELEV	F.S.
[illegible]56	840	[illegible]
42.00	830	[illegible]
38.37	840.0	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]65	798.0	[illegible]

F.S. = 1.50

ARC NO	X	Y	RADIUS	TANGENT ELEV	F.S.
1	58.49	879.41	69.41	810.0	2.003
2	50.00	880.00	60.00	820.0	1.860
3	47.51	879.79	54.79	825.0	1.543
4	47.38	877.37	47.38	830.0	1.561
5	54.91	885.09	50.09	835.0	1.641
6	45.18	897.65	55.65	842.0	2.038

REQUIRED FS = 1.5

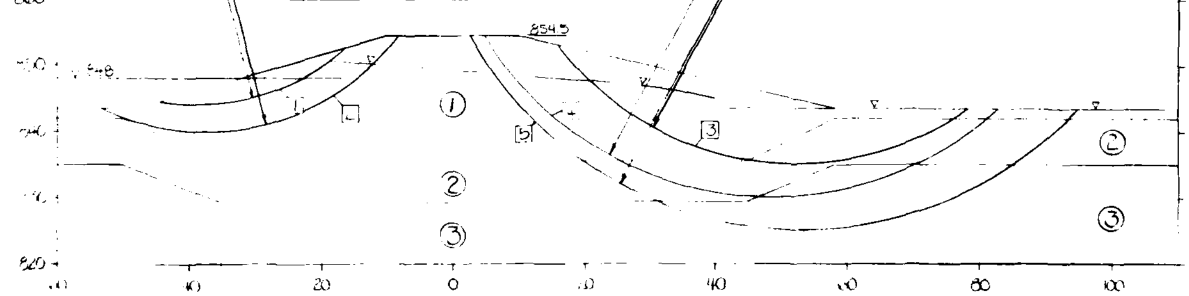


STEADY SEEPAGE FROM 851.0 AT END OF PRIMARY CONSOLIDATION

STA 8+25

REQUIRED F.S. = 1.0

ARC NO	X	Y	RADIUS	TANGENT ELEV	F.S.
1	38.93	878.04	34.04	844.0	1.447
2	37.42	876.70	36.70	840.0	1.712
3	52.01	880.24	45.24	835.0	1.443
4	48.27	881.00	51.00	830.0	1.417
5	52.62	882.37	57.37	825.0	1.479



STEADY SEEPAGE & PARTIAL POOL WITH EARTHQUAKE

STA 8+25

SYMBOL	DESCRIPTION	DATE	APPROVAL

DESIGNED BY: D.W.R.
DRAWN BY: D.W.R.
CHECKED BY: M.B.
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

HIGHWAY 100

STABILITY ANALYSIS, PARTIAL POOL, STEADY SEEPAGE & EARTHQUAKE CONDITIONS

DATE: AUGUST 1982

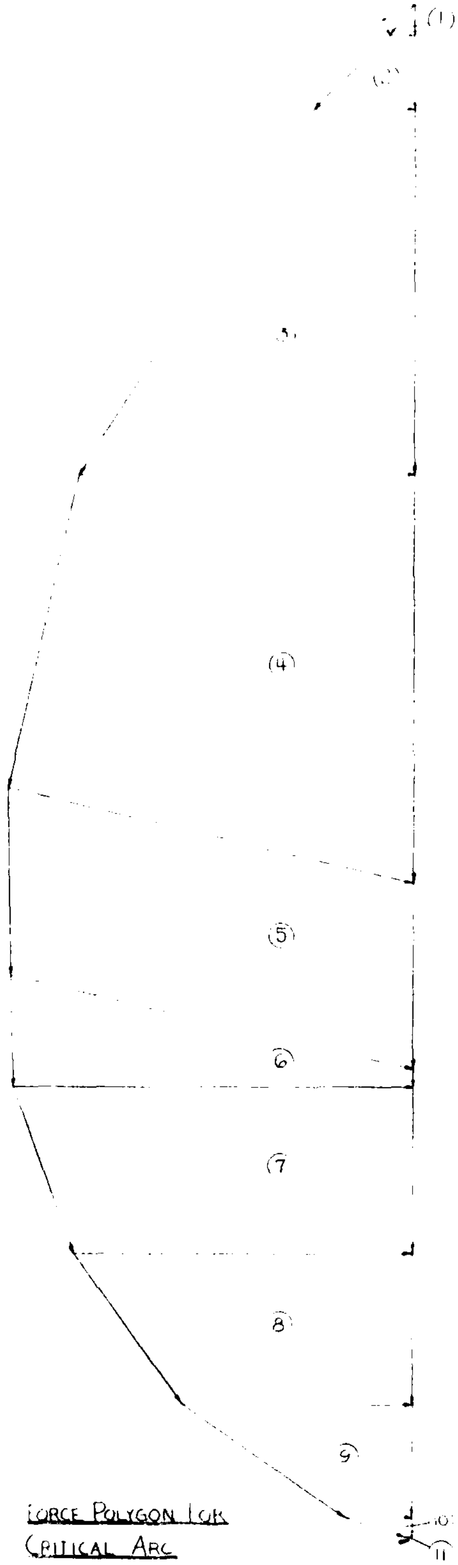
SCALE: AS SHOWN

DRAWING NUMBER: M34.3-R-5/230

SHEET C-2 OF C-39

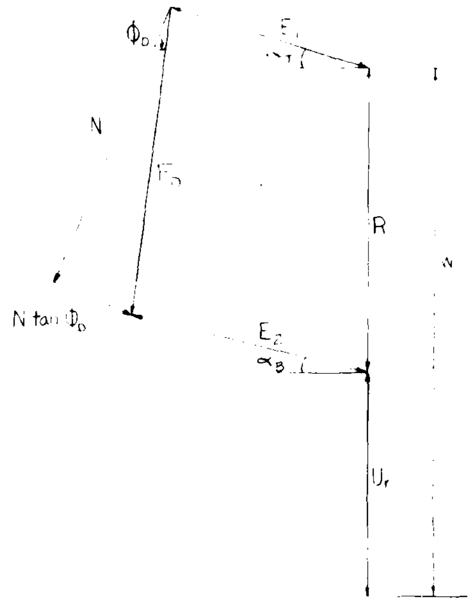
SAFETY PAYS

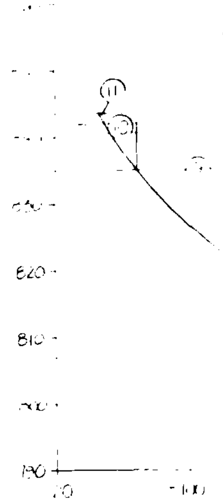
2



FORCE POLYGON FOR
CRITICAL ARC
SCALE 1" = 5 kips

CLOSURE ERROR [illegible] kips

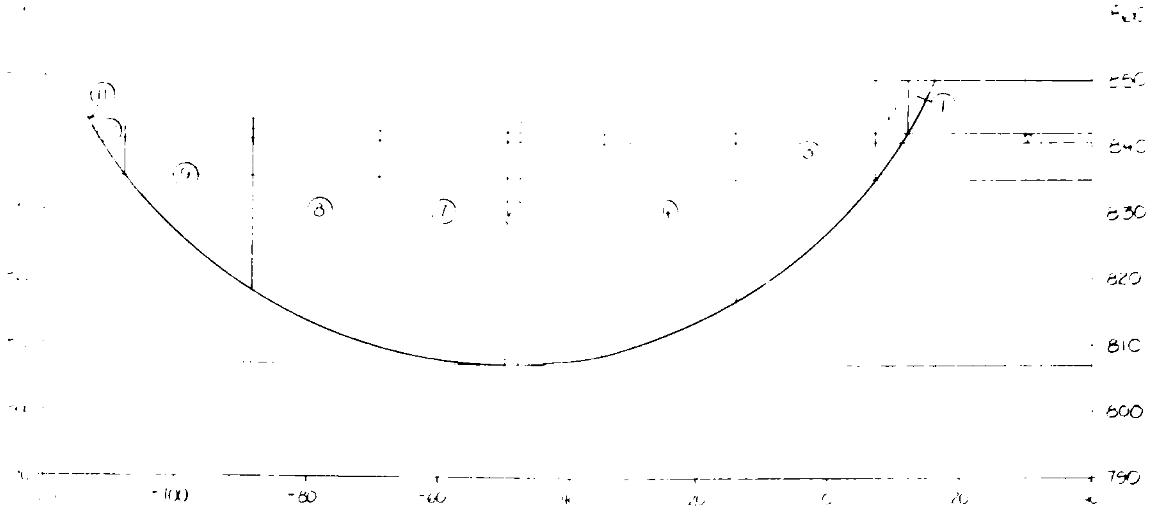




DEFINITION OF TERMS

[illegible] - SLICE NUMBER
W - TOTAL WEIGHT OF SLICE
U_r - WATER FORCE
R - RESULTANT OF TOTAL WT - WATER
Φ_D - DEVELOPED Φ PARAMETER
E_1 = RESULTING SIDE FORCE BETWEEN SLICE n & n-1
E_2 = RESULTING SIDE FORCE BETWEEN SLICE n & n+1
α_T & α_B - DIRECTION OF RESULTANT SIDE FORCE
N - NORMAL FORCE ON BOTTOM OF SLICE
F_D = RESULTANT OF NORMAL & FRICTIONAL COMPONENTS

SLICE NO	[illegible]
[illegible]	[illegible]
2	[illegible]
3	[illegible]
4	[illegible]
5	[illegible]
[illegible]	[illegible]
7	[illegible]
8	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]



CRITICAL ARC STAGE I END OF CONSTRUCTION

TABULATION OF SLICE DATA

SLICE NO	X-COORD	SLICE WIDTH	TOTAL WT (W)	WATER FORCE (U)	DIRECTION OF U	FORCE E	LEVEL	DIRECT FORCE	NORMAL STRESS	NORMAL FORCE (N)	ALPHA TOP	ALPHA BOT (α_B)		F_2
1	14.44	4.22	[illegible]	0.00	0.00	0.00	[illegible]	61.98	0.31	[illegible]	0.0	0.0	0.00	89
2	9.91	4.85	6.24	0.67	90.00	1.26	[illegible]	55.15	0.93	[illegible]	[illegible]	0	[illegible]	[illegible]
3	-3.14	21.24	49.47	21.83	90.00	4.12	0.00	39.94	1.18	[illegible]	0.0	0.0	[illegible]	[illegible]
4	-24.38	21.24	69.20	38.25	90.00	3.37	[illegible]	[illegible]	[illegible]	[illegible]	0.0	[illegible]	25.44	[illegible]
5	-41.50	13.00	40.90	26.77	90.00	1.95	[illegible]	[illegible]	[illegible]	14.07	[illegible]	[illegible]	[illegible]	[illegible]
6	-49.00	2.00	[illegible]	4.17	90.00	[illegible]	0.00	[illegible]	[illegible]	6.52	[illegible]	[illegible]	31.26	[illegible]
7	-59.58	9.16	51.99	39.30	90.00	[illegible]	[illegible]	[illegible]	68	[illegible]	[illegible]	0.0	[illegible]	[illegible]
8	-78.74	19.16	44.43	33.00	90.00	3.10	0.00	[illegible]	[illegible]	[illegible]	[illegible]	0.0	25.67	[illegible]
9	[illegible]	19.16	27.16	18.63	90.00	[illegible]	[illegible]	41.01	0.57	[illegible]	[illegible]	0.0	[illegible]	[illegible]
10	[illegible]	4.85	2.14	[illegible]	90.00	[illegible]	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	[illegible]	0.89	[illegible]	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

ALL ANGLES MEASURED FROM POSITIVE X AXIS. FORCES ARE IN KIPS

SYMBOL	DESCRIPTION	DATE	APPROVAL

DESIGNED BY: DWR
DRAWN BY: DWR
CHECKED BY: MB
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

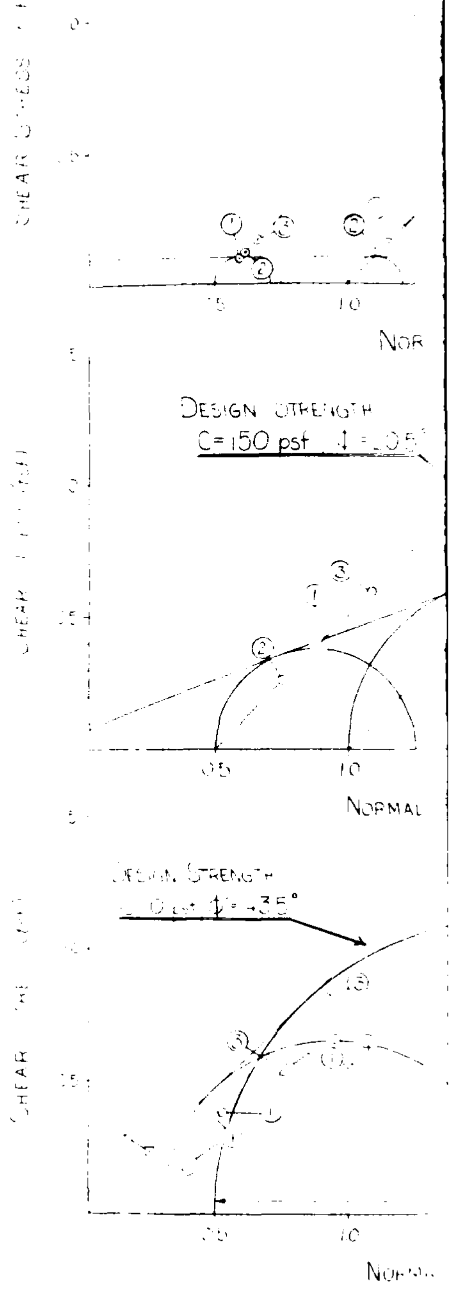
HIGHWAY 100
STABILITY ANALYSIS - TYPICAL CALCULATION OF CRITICAL FAILURE ARC

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER M34 3-R-5/231
SHEET C-3 OF C-39

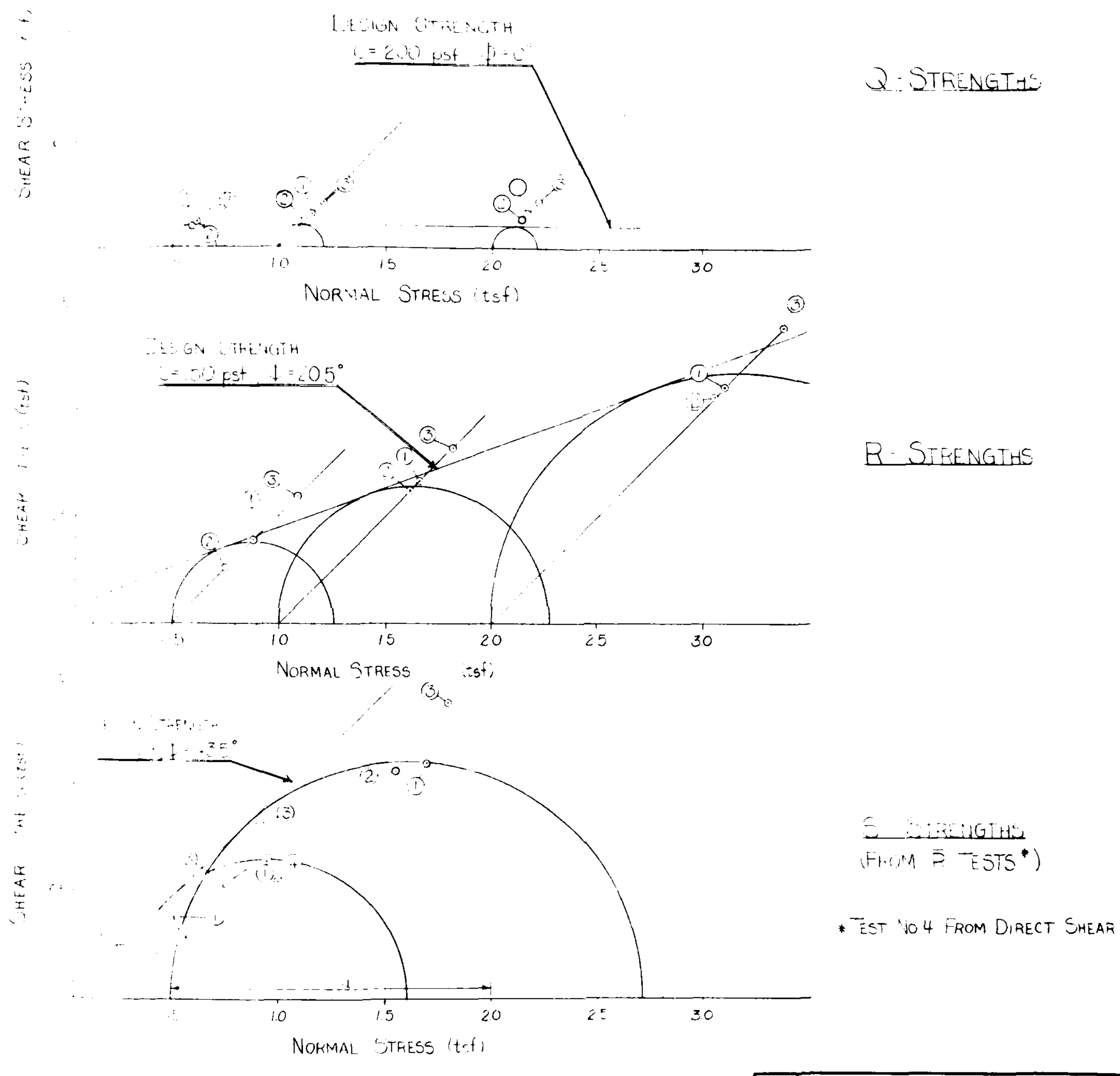
SAFETY PAYS

2

Test No	Boring No	Depth (FT)	Dry Unit Wt (pcf)	Moist Unit Wt	Sat Unit Wt (pcf)	Moisture Content	Specific Gravity	Void Ratio	Liquid Limit	Plastic Limit
1	BC-4B	17-19	27.2	77.4	78.0	184.7	2.35	4.39	185	[illegible]
2	BC-4Z	7.5-19.5	49.2	92.0	92.7	87.0	2.59	2.28	[illegible]	44
3	BC-4J	9.5-11	23.1	73.1	73.6	216.4	.94	4.24	266	178
4	BC-4C	2-4	12.3	65.3	66.6	431.2	1.52	6.71	—	—



NOTE ALL STRENGTH VALUES ...



All Strength Values Plotted At [illegible]% Strain

SYMBOL	DESCRIPTION	DATE	APPROVAL

DESIGNED BY: DWR
DRAWN BY: DWR
CHECKED BY: MB
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

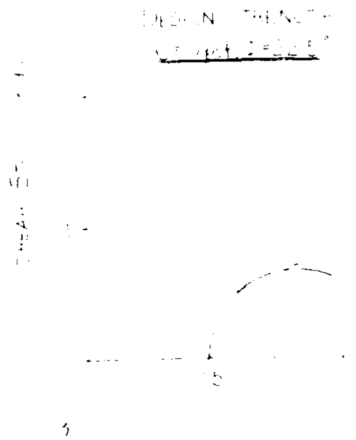
HIGHWAY 100

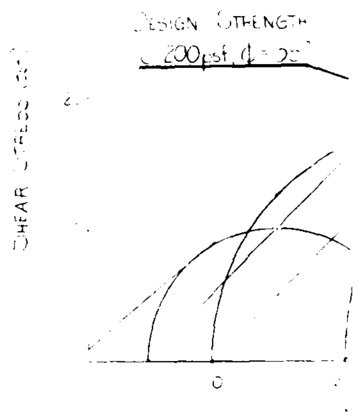
PEAT - MUCK
UNDISTURBED SHEAR STRENGTH PARAMETERS

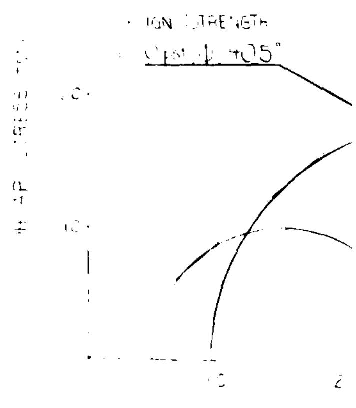
DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-5/232
SHEET C-4 OF C-39

2

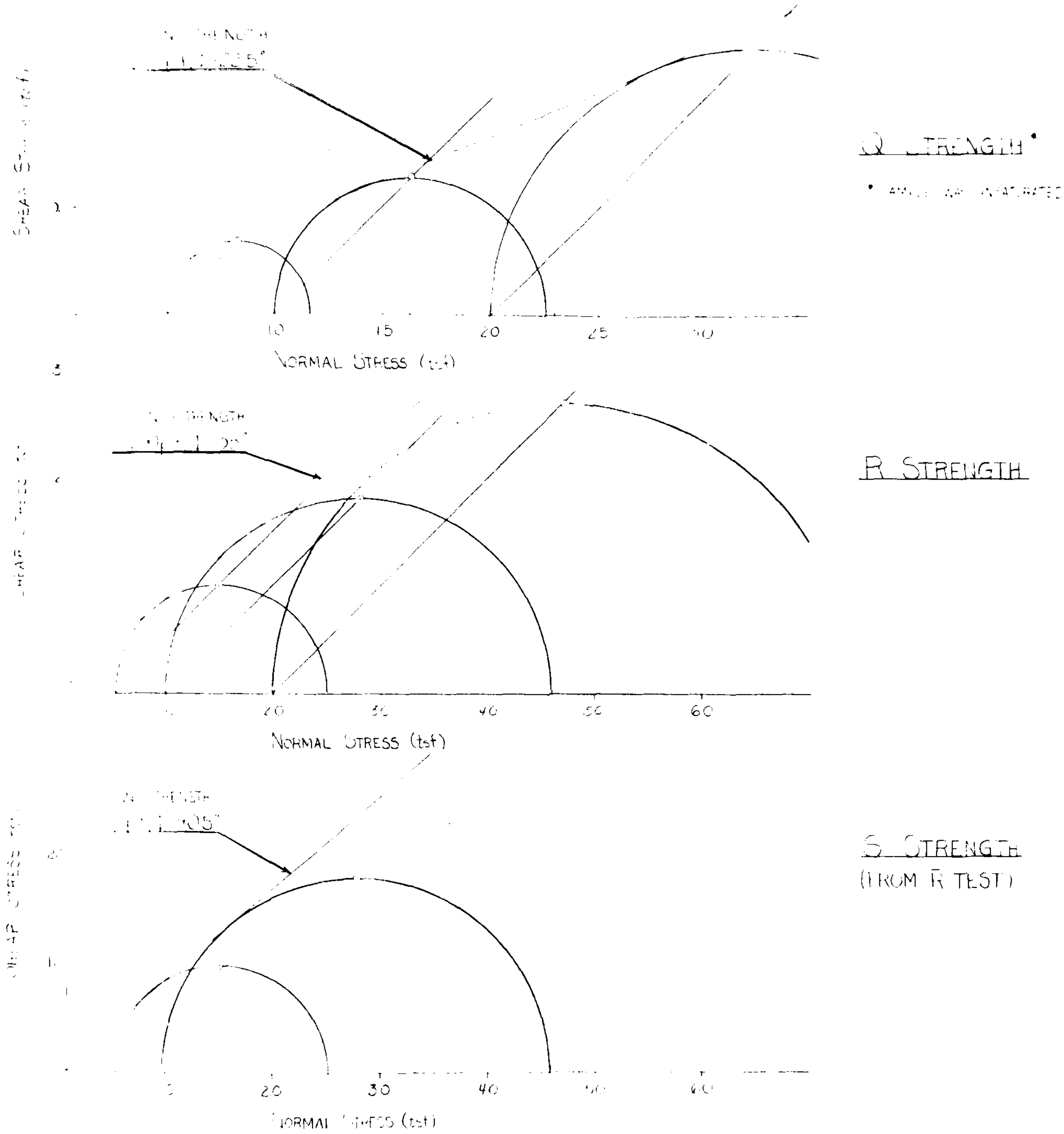
TEST NO	BORING NO	DEPTH (FT)	DRY UNIT WT (PCF)	MOIST UNIT WT	SAT UNIT WT (PCF)	MOISTURE CONTENT	SPECIFIC GRAVITY	VOID RATIO	LIQUID LIMIT	PLASTIC LIMIT
1	BC-4Z	27-29	98.3	123.0	124.1	25.1	2.67	0.69	24	22







NOTE ALL STRENGTH VAL



... VALUES PLOTTED AT 10% STRAIN

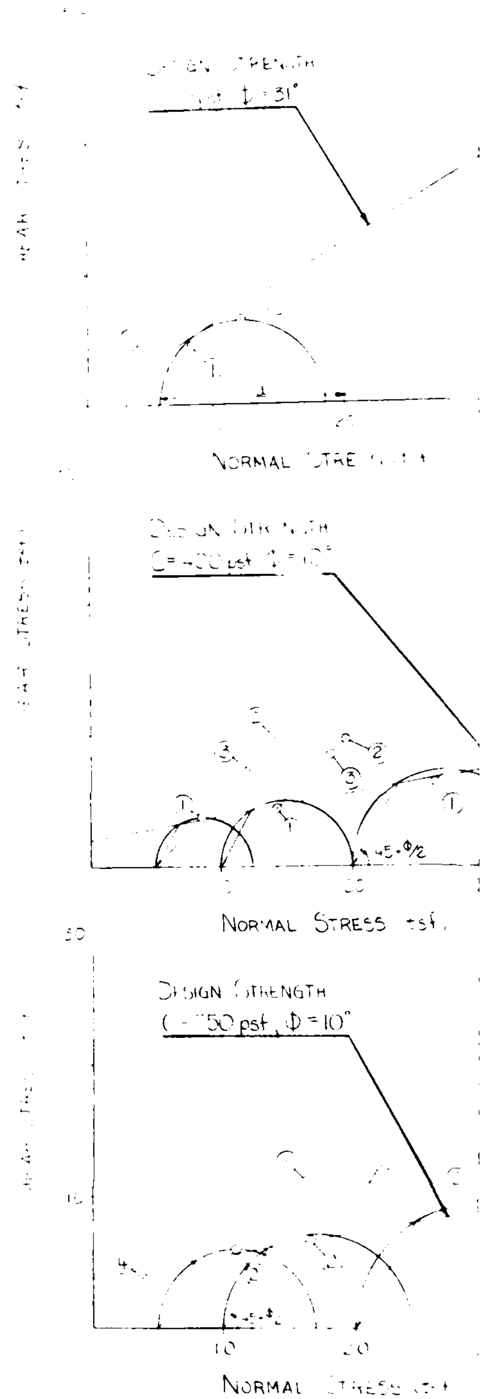
SYMBOL	DESCRIPTION	DATE	APPROVAL

DESIGNED BY: DWR
DRAWN BY: DWR
CHECKED BY: MB
SUBMITTED BY:
APPROVED:

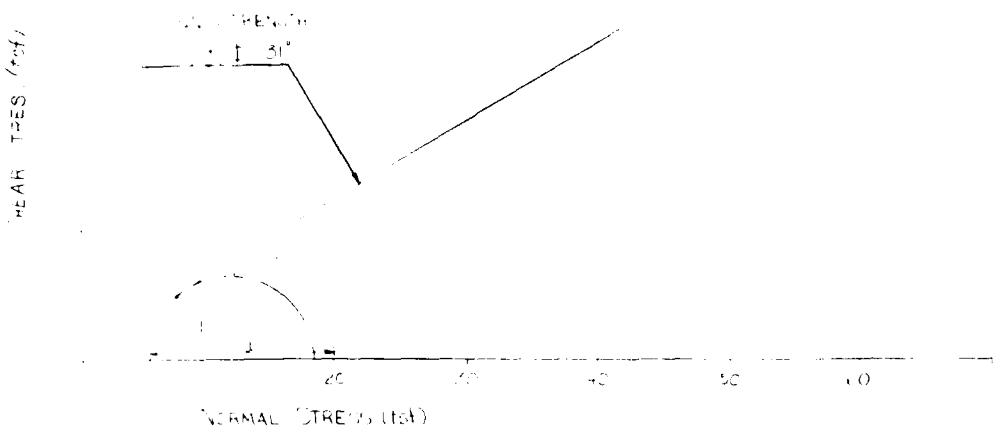
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
HIGHWAY 100
SILT
UNDISTURBED SHEAR STRENGTH PARAMETERS
DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-5/233
SHEET C-5 OF C-39

Test No	Boring No	Depth	Liquid Limit	Plastic Limit	Optimum M.C.	Sample M.C.	Max γ_d (pcf)	Sample γ_d (pcf)
1	81-60M	0-20'	33	14	15.4	15.6	111.1	105.3
2	BC-14C	5.5-7.7'	---	—	15.4	18.4	113.6	107.9
3	BC-14C	5.5-7.7'	31	15	15.4	.5.4	113.6	107.9
4*	BC-10A	7-9.5'	—	—	16.1	16.1	113.5	107.8

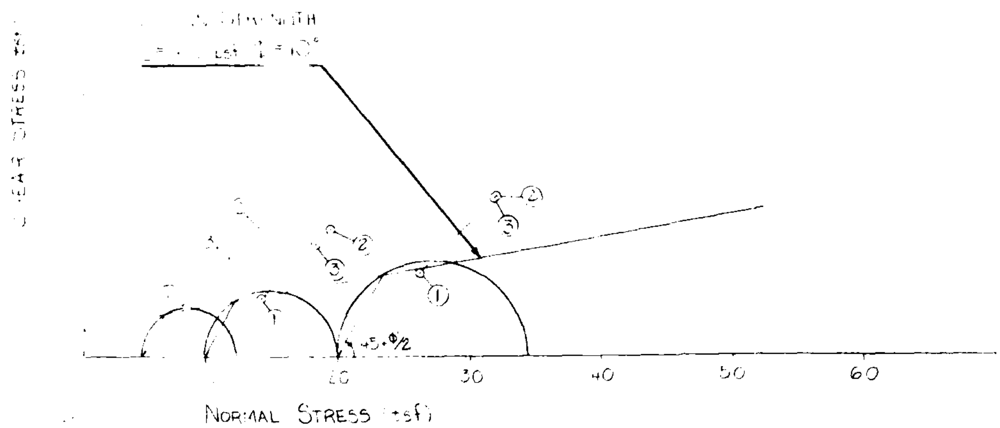
*Unconfined Compression Test



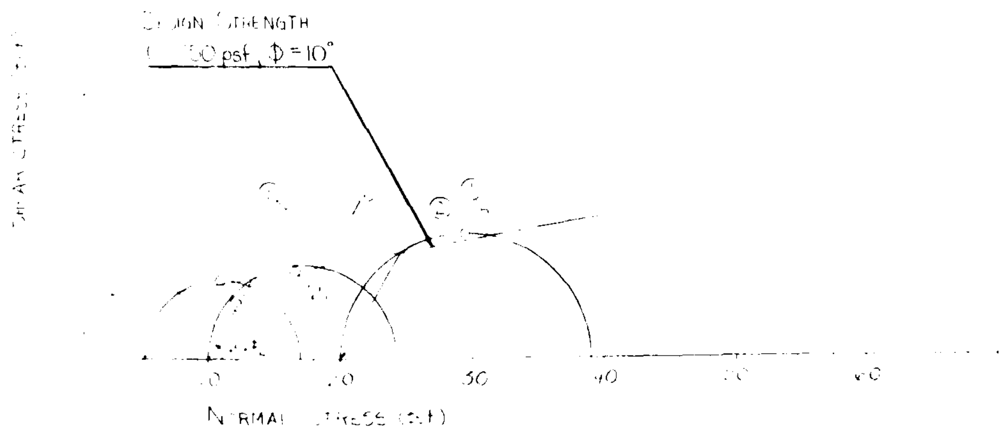
Note All Strength Values



S STRENGTH
(FROM $\bar{R}$ TEST)



R STRENGTHS



Q STRENGTHS

... NGTH VALUES PLOTTED AT 15% STRAIN

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: D.W.R
DRAWN BY: J.M.J.
CHECKED BY: M.B
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

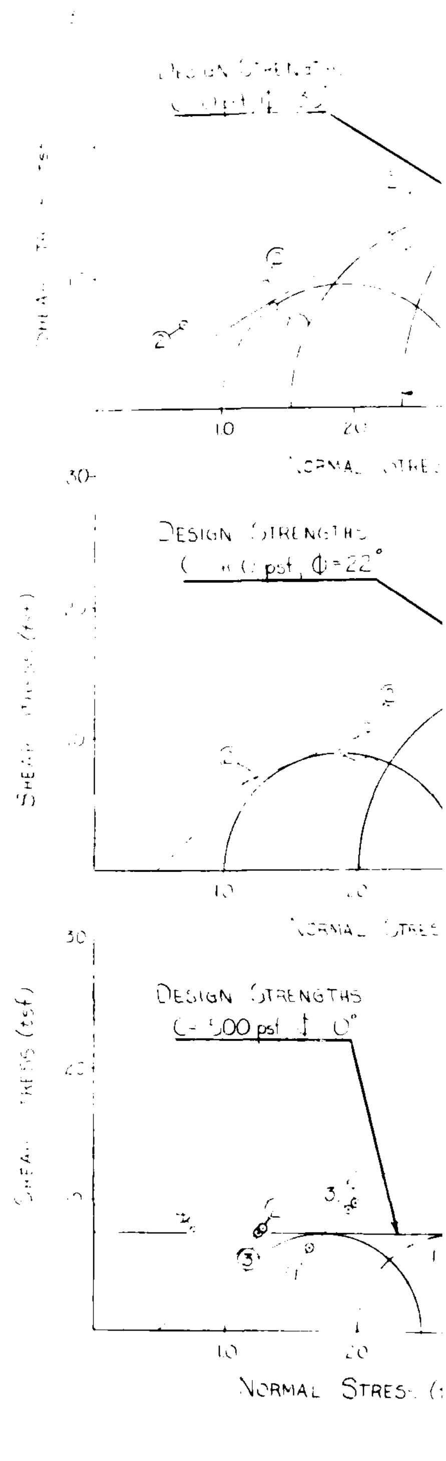
EDGEWOOD EMBANKMENT
BORROW AREA-CLAY TILL
REMOLDED SHEAR STRENGTH PARAMETERS

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-5/234
SHEET C-6 OF C-39

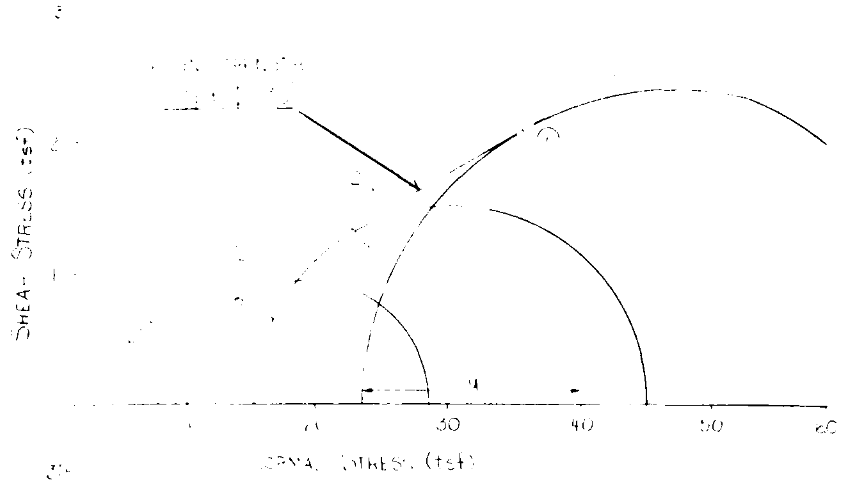
2

TEST NO	BORING NO	DEPTH (FT)	DRY UNIT WT (PCF)	MOIST UNIT WT	SAT UNIT WT (PCF)	MOISTURE CONTENT	SPECIFIC GRAVITY	VOID RATIO	LIQUID LIMIT	PLASTIC LIMIT
1	81-58M	11-13	112.1	131.8	136.3	17.6	2.67	0.49	32	12
2	BC-15D	9.3-11.4	116.1	1347		16.0	—	—	26	14
3	BC-10B	4.5-7	1140	345		18.0	—	—	30	15
4 *	BC-10C	6.5-7	113.5	1329	—	17.1	—	—	25	15

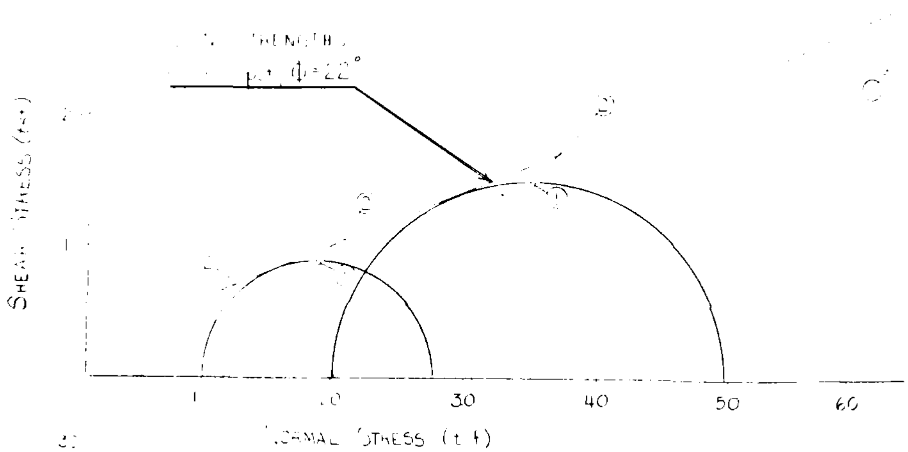
* UNCONFINED COMPRESSION TEST



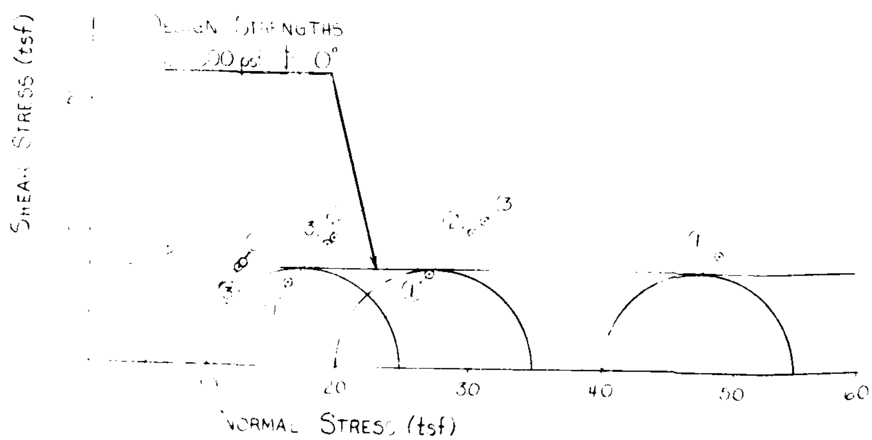
NOTE ALL STRENGTH DATA TAKE



S STRENGTHS
(FROM R TESTS)



R STRENGTHS



Q STRENGTHS

NOTE ALL STRENGTH DATA TAKEN AT 15% STRAIN

SYMBOL	DESCRIPTION	DATE	APPROVAL

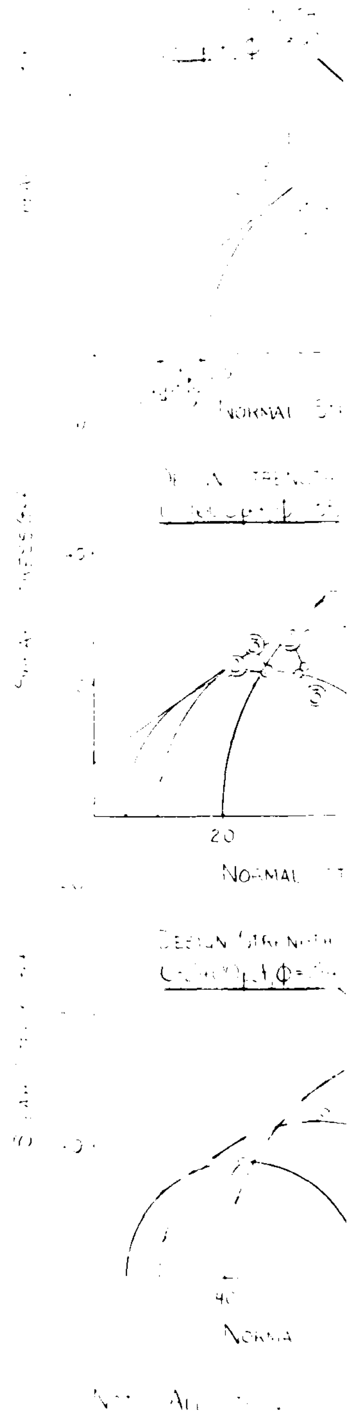
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: D.W.R.
DRAWN BY: J.M.J.
CHECKED BY: M.B.
SUBMITTED BY:
APPROVED:

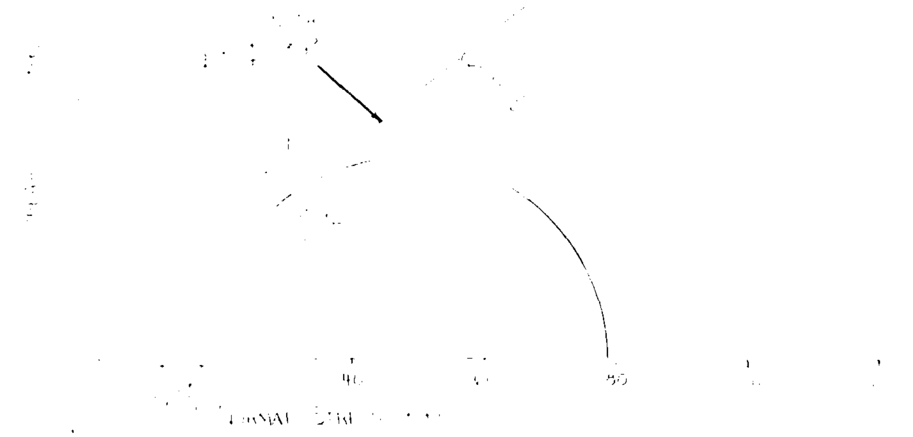
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
EDGEWOOD EMBANKMENT
FOUNDATION CLAY
UNDISTURBED SHEAR STRENGTH PARAMETERS

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-5/235
SHEET C-7 OPC-39

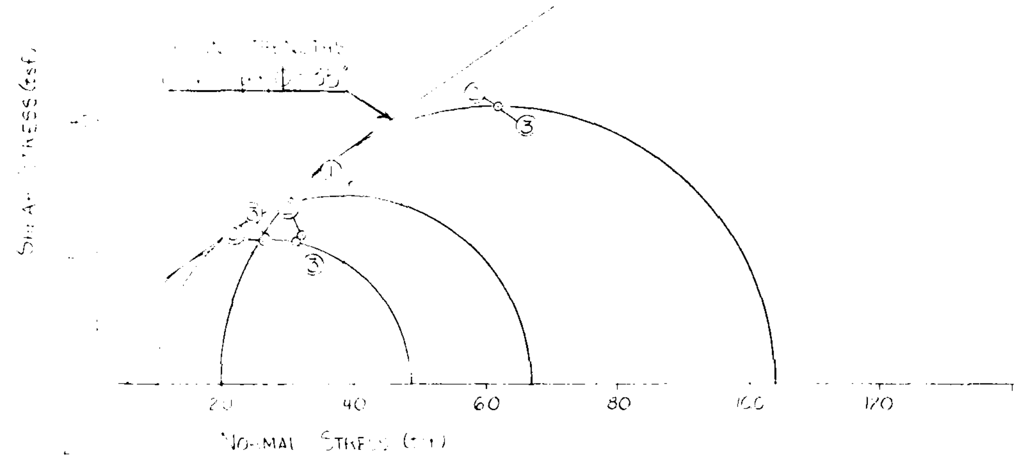
TEST NO	BORING NO	DEPTH (FT)	DRY UNIT WT (PCF)	MOIST UNIT WT	SAT UNIT WT (PCF)	MOISTURE CONTENT	SPECIFIC GRAVITY	VOID RATIO	LIQUID LIMIT	PLASTIC LIMIT
1	81-58M	1125	1089	1313	1313	206	269	0 54	-	
2	BC-15D	12-14								
3	BC-15D	12-14								



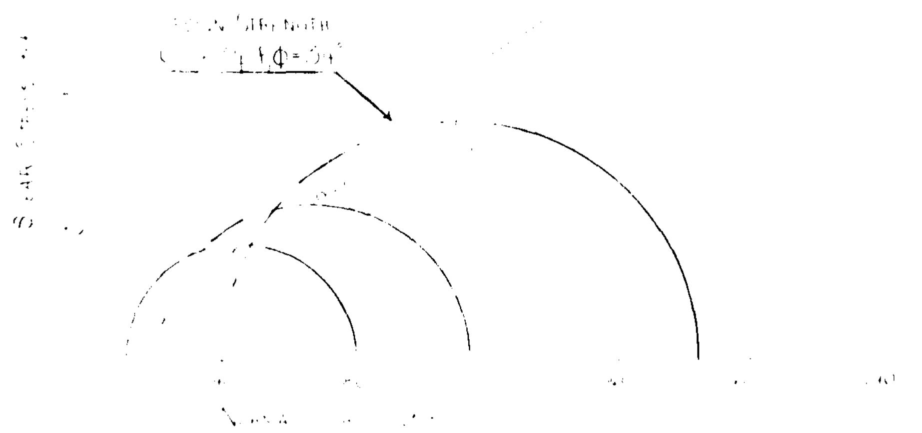
S STRENGTHS
(From R Tests)



R STRENGTHS



Q STRENGTHS



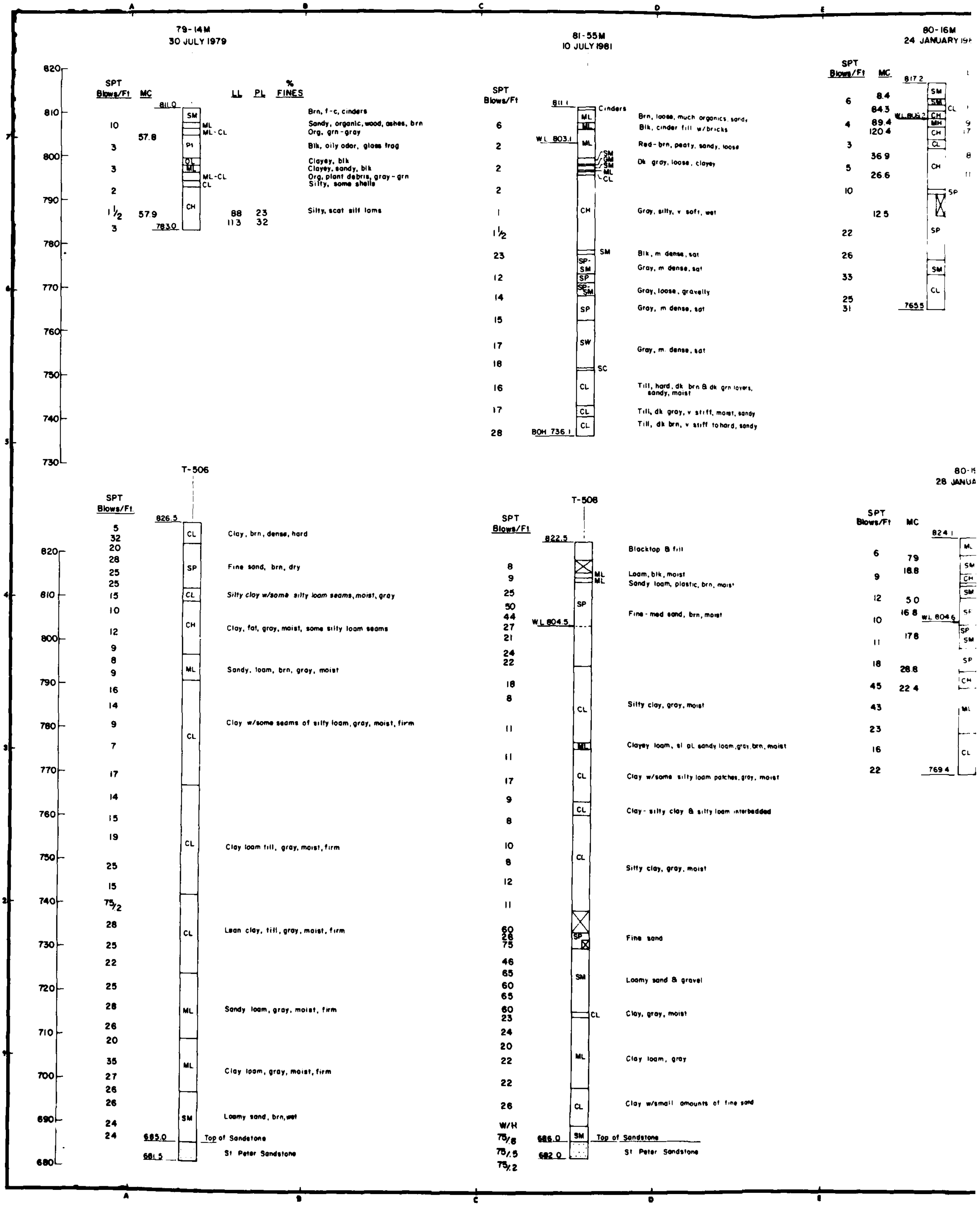
SYMBOL	DESCRIPTION	DATE	APPROVAL

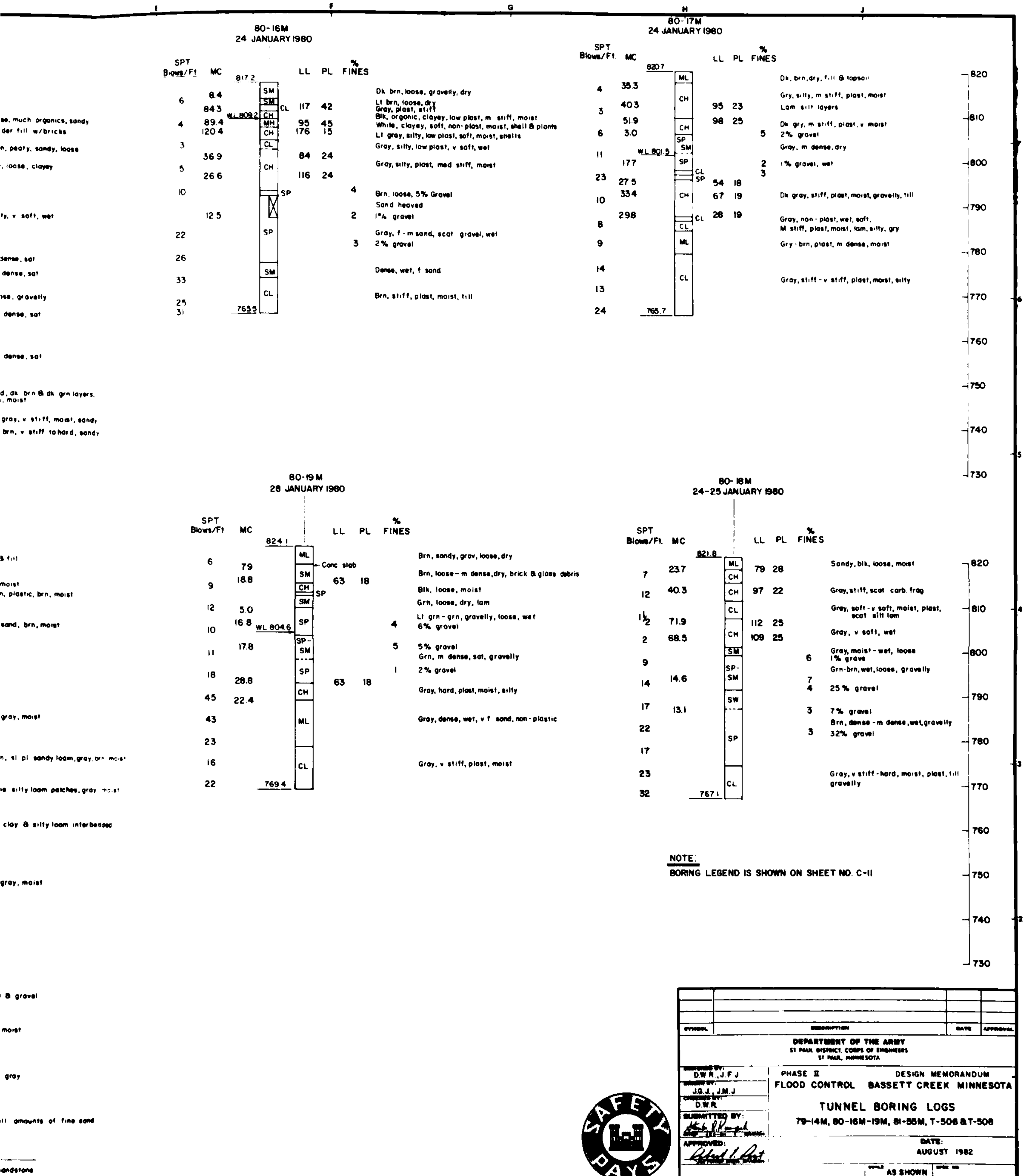
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY DWR
DRAWN BY JMJ
CHECKED BY MB
SUBMITTED BY:
APPROVED

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
EDGEWOOD EMBANKMENT
FOUNDATION SILT
UNDISTURBED SHEAR STRENGTH PARAMETERS

DATE: AUGUST 1982
SCALE AS SHOWN
DRAWING NUMBER M34 3-R-5/236
SHEET C-8 OF C-39


79-14M
30 JULY 1979
SPT Blows/Ft
MC
LL
PL
% FINES
Brn, f-c, cinders
Sandy, organic, wood, ashes, brn
Org, grn-gray
Blk, oily odor, glass frag
Clayey, blk
Clayey, sandy, blk
Org, plant debris, gray-grn
Silty, some shells
Silty, scat silt loms
81-55M
10 JULY 1981
Cinders
Brn, loose, much organics, sandy
Blk, cinder fill w/bricks
Red-brn, peaty, sandy, loose
Dk gray, loose, clayey
Gray, silty, v soft, wet
Blk, m dense, sat
Gray, m dense, sat
Gray, loose, gravelly
Gray, m dense, sat
Gray, m dense, sat
Till, hard, dk brn & dk grn layers, sandy, moist
Till, dk gray, v stiff, moist, sandy
Till, dk brn, v stiff to hard, sandy
80-16M
24 JANUARY 19
T-506
Clay, brn, dense, hard
Fine sand, brn, dry
Silty clay w/some silty loam seams, moist, gray
Clay, fat, gray, moist, some silty loam seams
Sandy, loam, brn, gray, moist
Clay w/some seams of silty loam, gray, moist, firm
Clay loam till, gray, moist, firm
Lean clay, till, gray, moist, firm
Sandy loam, gray, moist, firm
Clay loam, gray, moist, firm
Loamy sand, brn, wet
Top of Sandstone
St Peter Sandstone
T-508
Blacktop & fill
Loam, blk, moist
Sandy loam, plastic, brn, moist
Fine-med sand, brn, moist
Silty clay, gray, moist
Clayey loam, sl gl sandy loam, gray, brn, moist
Clay w/some silty loam patches, gray, moist
Clay-silty clay & silty loam interbedded
Silty clay, gray, moist
Fine sand
Loamy sand & gravel
Clay, gray, moist
Clay loam, gray
Clay w/small amounts of fine sand
Top of Sandstone
St Peter Sandstone
80-15
28 JANUA



NOTE:
BORING LEGEND IS SHOWN ON SHEET NO. C-11

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: D.W.R., J.F.J
DRAWN BY: J.G.J., J.M.J
CHECKED BY: D.W.R.
SUBMITTED BY:
APPROVED:

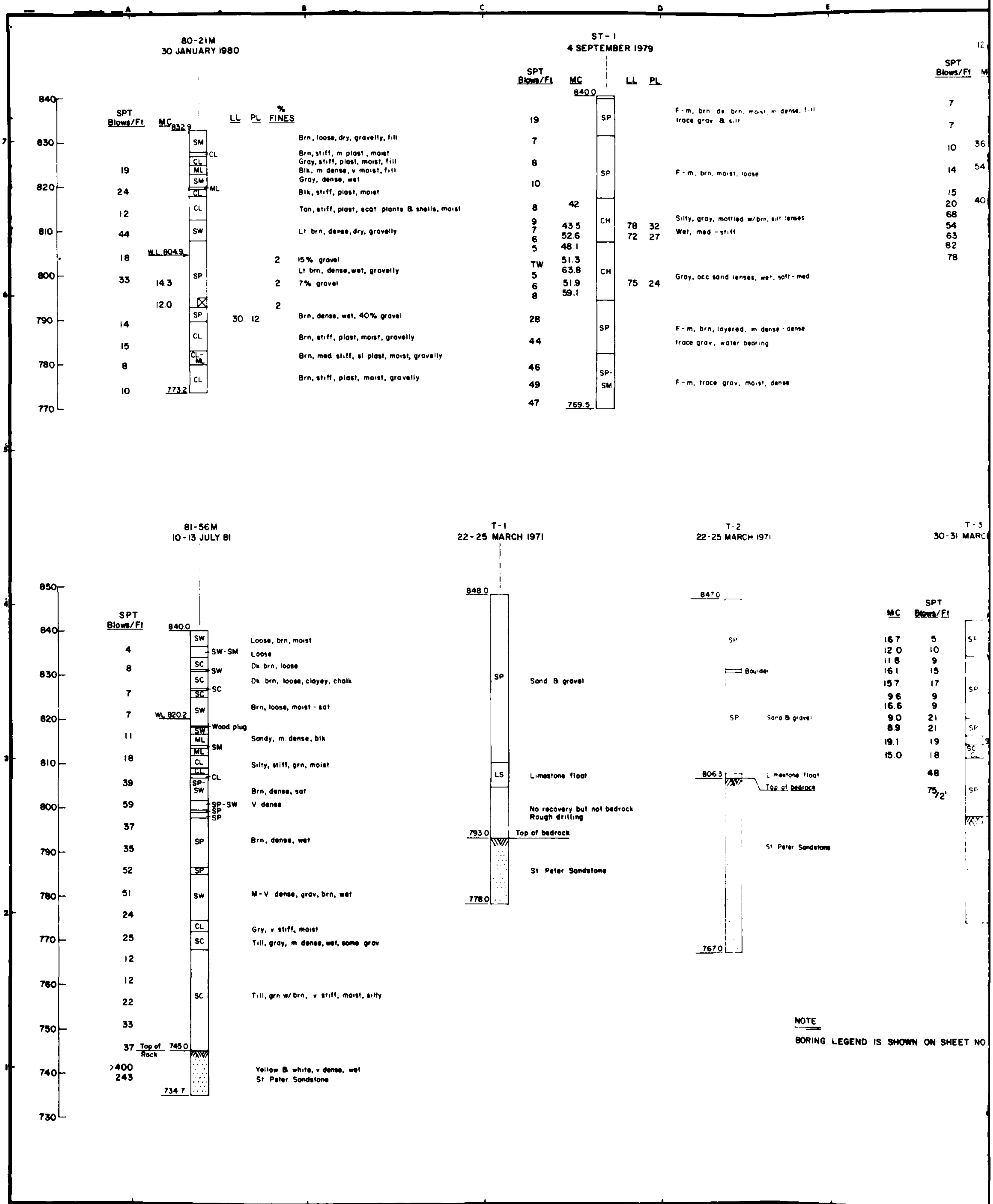
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

TUNNEL BORING LOGS
79-14M, 80-16M-19M, 81-55M, T-506 & T-508

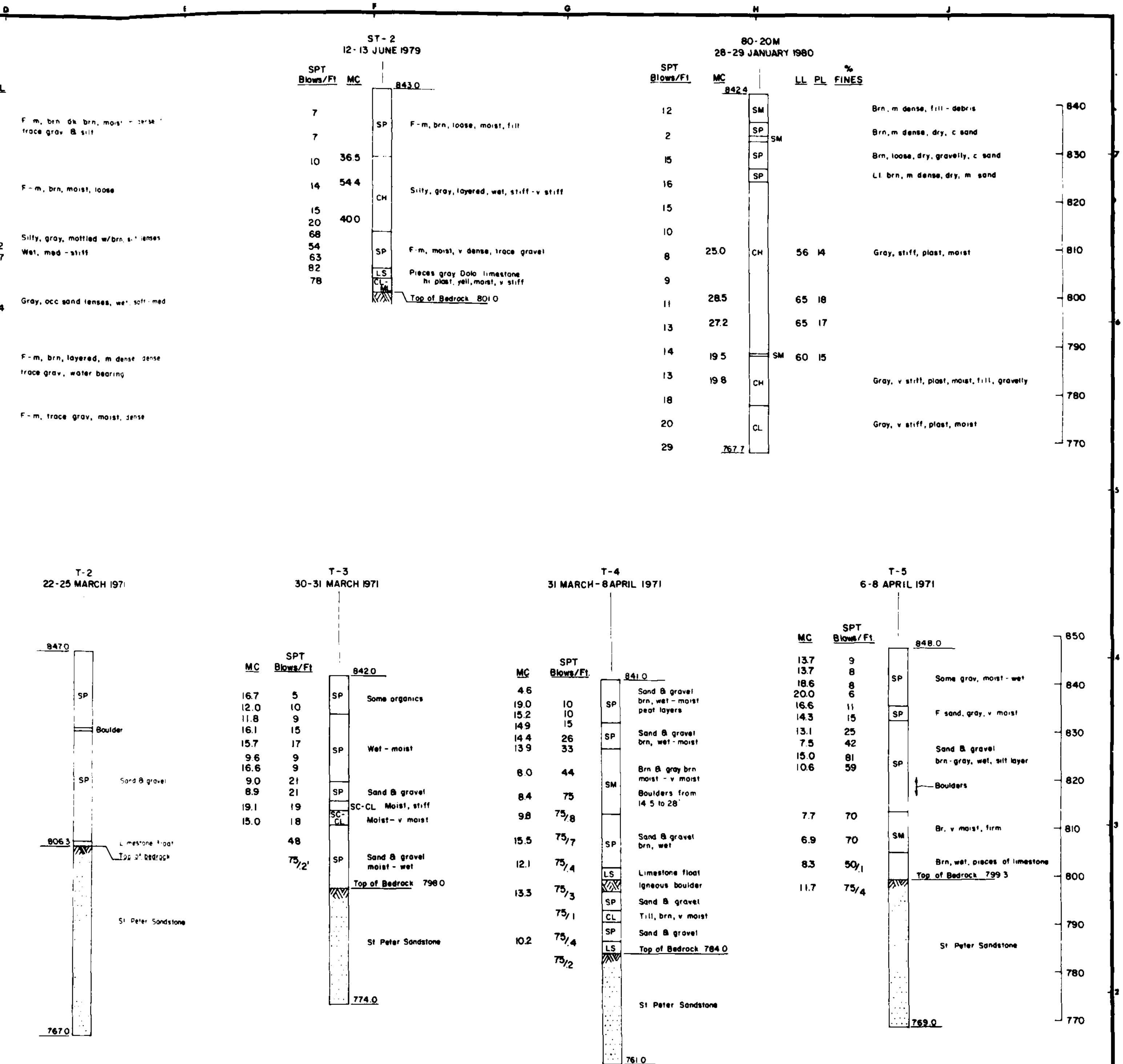
DATE: AUGUST 1982

SCALE: AS SHOWN

DRAWING NUMBER
M34.3-R-5/237
SHEET C-9 OF C-39



80-21M
30 JANUARY 1980
SPT Blows/Ft
MC
LL
PL
% FINES
832.9
Brn, loose, dry, gravelly, fill
Brn, stiff, m plast, moist
Gray, stiff, plast, moist, fill
Blk, m dense, v moist, fill
Gray, dense, wet
Blk, stiff, plast, moist
Tan, stiff, plast, scat plants & shells, moist
Lt brn, dense, dry, gravelly
W.L. 804.9
15% gravel
Lt brn, dense, wet, gravelly
7% gravel
Brn, dense, wet, 40% gravel
Brn, stiff, plast, moist, gravelly
Brn, med stiff, sl plast, moist, gravelly
Brn, stiff, plast, moist, gravelly
773.2
ST-1
4 SEPTEMBER 1979
840.0
F-m, brn-dk brn, moist, m dense, fill
trace grav & silt
F-m, brn, moist, loose
Silty, gray, mottled w/brn, silt lenses
Wet, med-stiff
Gray, occ sand lenses, wet, soft-med
F-m, brn, layered, m dense-dense
trace grav, water bearing
F-m, trace grav, moist, dense
769.5
81-5EM
10-13 JULY 81
840.0
Loose, brn, moist
Loose
Dk brn, loose
Dk brn, loose, clayey, chalk
Brn, loose, moist-sat
WL 820.2
Wood plug
Sandy, m dense, blk
Silty, stiff, grn, moist
Brn, dense, sat
V. dense
Brn, dense, wet
M-V dense, grav, brn, wet
Gry, v stiff, moist
Till, gray, m dense, wet, some grav
Till, grn w/brn, v stiff, moist, silty
Top of Rock 745.0
Yellow & white, v dense, wet
St Peter Sandstone
734.7
T-1
22-25 MARCH 1971
848.0
Sand & gravel
Limestone float
No recovery but not bedrock
Rough drilling
793.0 Top of bedrock
St Peter Sandstone
778.0
T-2
22-25 MARCH 1971
847.0
Boulder
Sand & gravel
806.3
Limestone float
Top of bedrock
St Peter Sandstone
767.0
T-3
30-31 MARC
NOTE
BORING LEGEND IS SHOWN ON SHEET NO



NOTE

BORING LEGEND IS SHOWN ON SHEET NO. C-11

SYMBOL	DESCRIPTION	DATE	APPROVAL

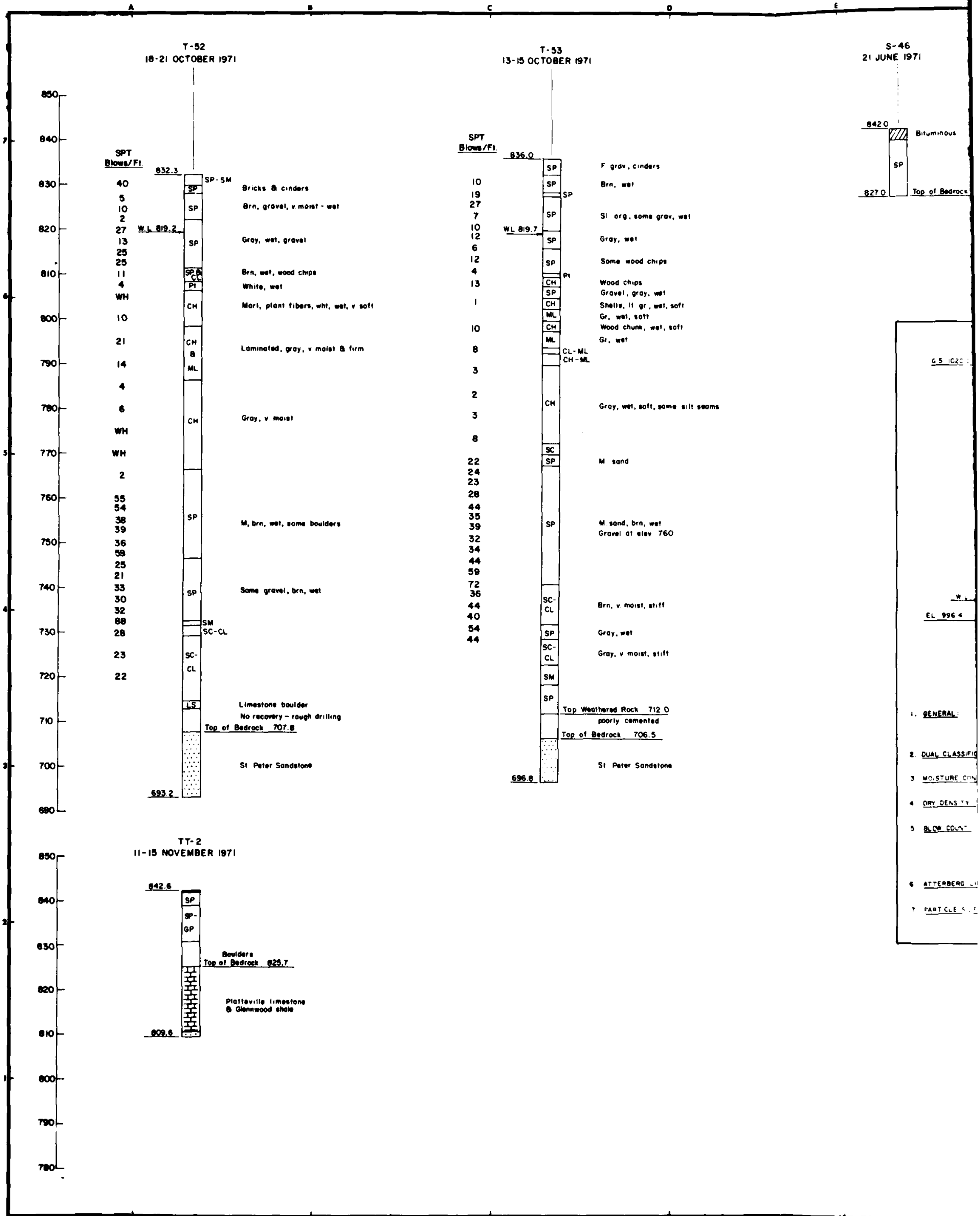
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

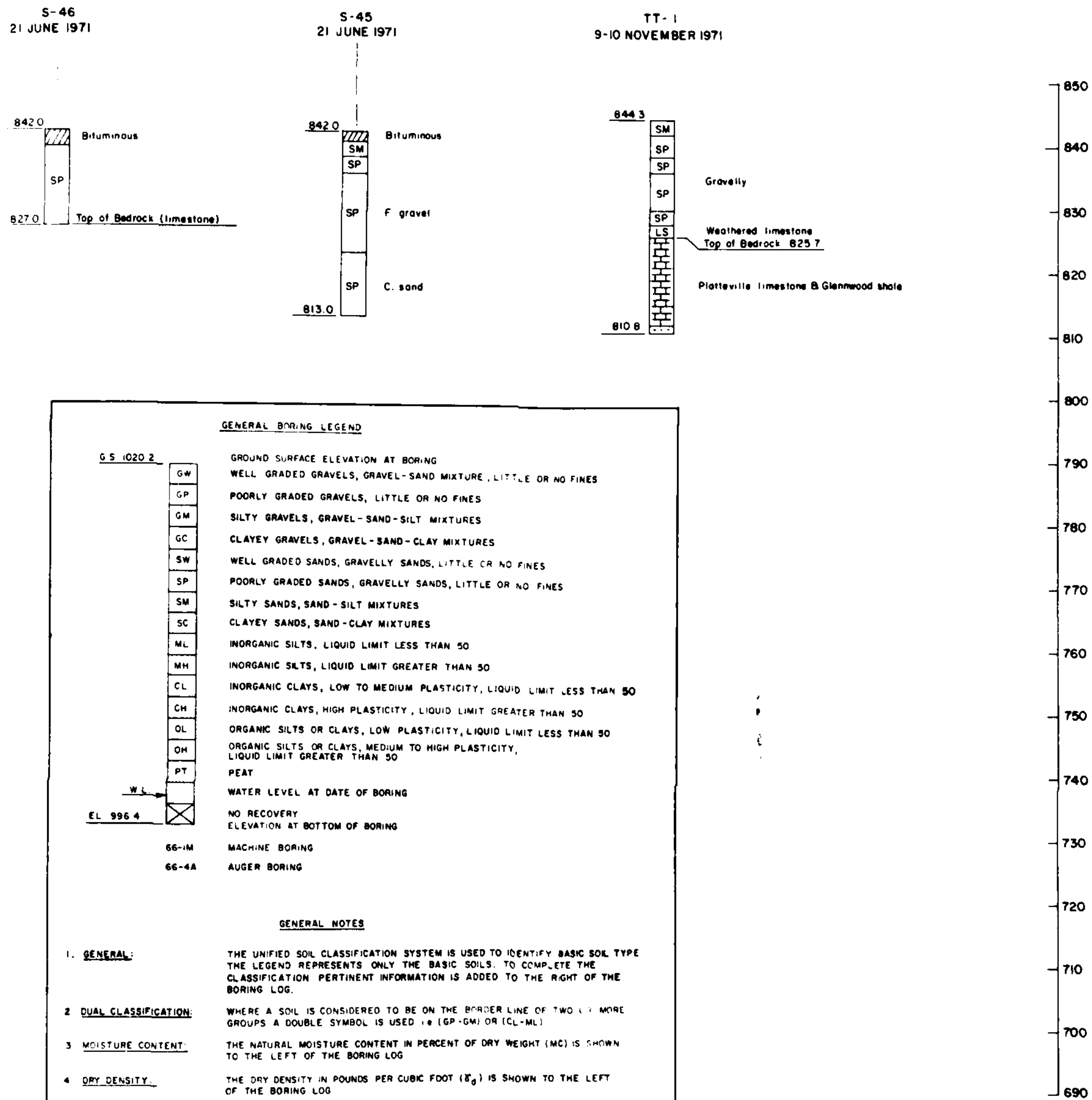
DESIGNED BY: DWR JFJ
DRAWN BY: JGJ JMJ
CHECKED BY: DWR
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

TUNNEL BORING LOGS
80-20M, 21M, 81-56M, ST-1, ST-2, T-1 TO T-5

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER M34.3-R-5/238
SHEET C-10 OF C-39


T-52
18-21 OCTOBER 1971
SPT
Blows/Ft.
832.3
SP-SM
Bricks & cinders
Brn, gravel, v moist - wet
W.L. 819.2
Gray, wet, gravel
Brn, wet, wood chips
White, wet
Marl, plant fibers, wht, wet, v soft
Laminated, gray, v moist & firm
Gray, v. moist
M, brn, wet, some boulders
Some gravel, brn, wet
SM
SC-CL
Limestone boulder
No recovery – rough drilling
Top of Bedrock 707.8
St Peter Sandstone
693.2
40 5 10 2 27 13 25 25 11 4 WH 10 21 14 4 6 WH WH 2 55 54 38 39 36 59 25 21 33 30 32 88 28 23 22
T-53
13-15 OCTOBER 1971
SPT
Blows/Ft.
836.0
F grav, cinders
Brn, wet
Sl org, some grav, wet
WL 819.7
Gray, wet
Some wood chips
Pt
Wood chips
Gravel, gray, wet
Shells, lt gr, wet, soft
Gr, wet, soft
Wood chunk, wet, soft
Gr, wet
CL-ML
CH-ML
Gray, wet, soft, some silt seams
M sand
M sand, brn, wet
Gravel at elev 760
Brn, v moist, stiff
Gray, wet
Gray, v moist, stiff
Top Weathered Rock 712.0
poorly cemented
Top of Bedrock 706.5
St Peter Sandstone
696.8
10 19 27 7 10 12 6 12 4 13 1 10 8 3 2 3 8 22 24 23 28 44 35 39 32 34 44 59 72 36 44 40 54 44
S-46
21 JUNE 1971
842.0
Bituminous
827.0
Top of Bedrock
TT-2
11-15 NOVEMBER 1971
842.6
Boulders
Top of Bedrock 825.7
Platteville limestone
& Glenwood shale
809.6
850 840 830 820 810 800 790 780 770 760 750 740 730 720 710 700 690
1. GENERAL:
2. DUAL CLASSIFIC
3. MOISTURE CON
4. DRY DENSITY
5. BLOW COUNT
6. ATTERBERG LI
7. PARTICLE SI
EL 996.4
G.S. 1020



GENERAL BORING LEGEND

G.S. 1020.2	GROUND SURFACE ELEVATION AT BORING
GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURE, LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND-SILT MIXTURES
SC	CLAYEY SANDS, SAND-CLAY MIXTURES
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
MH	INORGANIC SILTS, LIQUID LIMIT GREATER THAN 50
CL	INORGANIC CLAYS, LOW TO MEDIUM PLASTICITY, LIQUID LIMIT LESS THAN 50
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY, LIQUID LIMIT LESS THAN 50
OH	ORGANIC SILTS OR CLAYS, MEDIUM TO HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
PT	PEAT
W.L.	WATER LEVEL AT DATE OF BORING
	NO RECOVERY
EL. 996.4	ELEVATION AT BOTTOM OF BORING
66-1M	MACHINE BORING
66-4A	AUGER BORING

GENERAL NOTES

1. GENERAL: THE UNIFIED SOIL CLASSIFICATION SYSTEM IS USED TO IDENTIFY BASIC SOIL TYPE. THE LEGEND REPRESENTS ONLY THE BASIC SOILS. TO COMPLETE THE CLASSIFICATION PERTINENT INFORMATION IS ADDED TO THE RIGHT OF THE BORING LOG.
2. DUAL CLASSIFICATION: WHERE A SOIL IS CONSIDERED TO BE ON THE BORDER LINE OF TWO OR MORE GROUPS A DOUBLE SYMBOL IS USED i.e. (GP-GM) OR (CL-ML)
3. MOISTURE CONTENT: THE NATURAL MOISTURE CONTENT IN PERCENT OF DRY WEIGHT (MC) IS SHOWN TO THE LEFT OF THE BORING LOG
4. DRY DENSITY: THE DRY DENSITY IN POUNDS PER CUBIC FOOT (γ_d) IS SHOWN TO THE LEFT OF THE BORING LOG
5. BLOW COUNT: BLOW COUNTS ARE SHOWN TO THE LEFT OF THE BORING LOGS AND EXCEPT AS NOTED ARE THE NUMBER OF BLOWS NECESSARY TO DRIVE THE SAMPLER USED A DISTANCE OF 12 INCHES. STANDARD BLOW COUNTS ARE FOR A STANDARD PENETRATION TEST, USING A 1 3/8" X 2" SAMPLER, 140 LB HAMMER AND A 30" DROP. FOR NON-STANDARD BLOW COUNTS, SAMPLER SIZE, HAMMER WEIGHT AND/OR HEIGHT OF DROP ARE AS SHOWN
6. ATTERBERG LIMITS: LIQUID LIMIT (LL) AND PLASTIC LIMIT (PL) ARE SHOWN TO THE RIGHT OF THE BORING LOG.
7. PARTICLE SIZE: FINE, MEDIUM AND COARSE SAND ARE DESIGNATED BY THE LETTERS F, M & C TO THE RIGHT OF THE BORING LOG. FOR GRAVELS MAXIMUM PARTICLE SIZE FOUND IN SAMPLE IS GIVEN. FOR MIXED MATERIALS, SIGNIFICANT PERCENTAGES MAY ALSO BE GIVEN

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

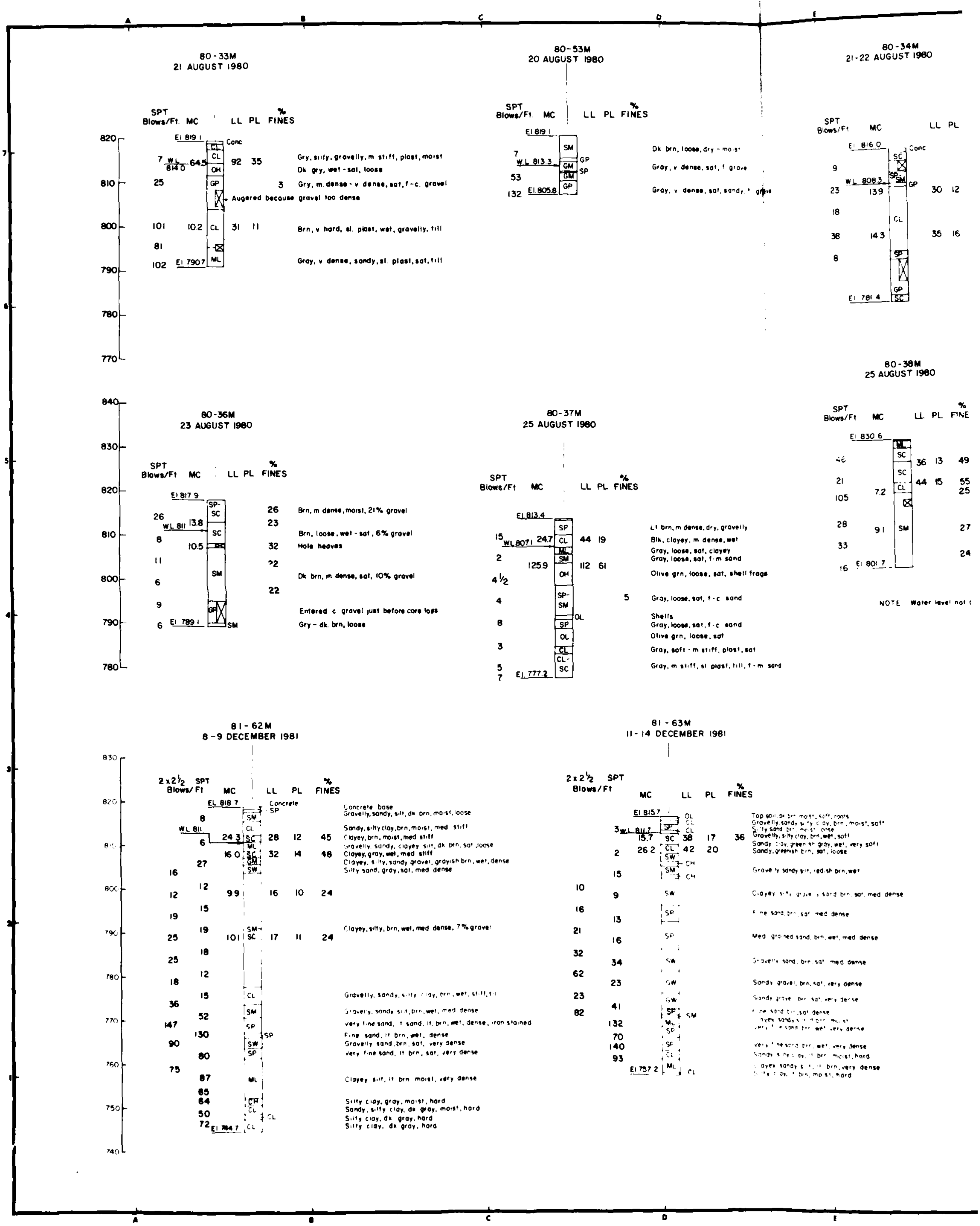
DESIGNED BY: D.W.R., J.F.J.
DRAWN BY: J.G.J., J.M.J.
CHECKED BY: D.W.R.
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

TUNNEL BORING LOGS
T-52, T-53, S-45, S-46, TT-1

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER M34.3-R-5/239
SHEET C-11 OF C-39

2



80-33M
21 AUGUST 1980
SPT Blows/Ft. MC LL PL % FINES
El 819.1
Conc
WL 814.0
Gry, silty, gravelly, m stiff, plast, moist
Dk gry, wet - sat, loose
Gry, m dense - v dense, sat, f-c. gravel
Augered because gravel too dense
Brn, v hard, sl. plast, wet, gravelly, till
El 790.7
Gray, v dense, sandy, sl. plast, sat, till
80-53M
20 AUGUST 1980
SPT Blows/Ft. MC LL PL % FINES
El 819.1
WL 813.3
El 805.8
Dk brn, loose, dry - moist
Gray, v dense, sat, f grave
Gray, v dense, sat, sandy, f grave
80-34M
21-22 AUGUST 1980
SPT Blows/Ft MC LL PL
El 816.0
Conc
WL 808.3
El 781.4
80-38M
25 AUGUST 1980
SPT Blows/Ft MC LL PL % FINE
El 830.6
El 801.7
NOTE Water level not c
80-36M
23 AUGUST 1980
SPT Blows/Ft MC LL PL % FINES
El 817.9
WL 811
El 789.1
Brn, m dense, moist, 21% gravel
Brn, loose, wet - sat, 6% gravel
Hole heaves
Dk brn, m dense, sat, 10% gravel
Entered c gravel just before core loss
Gry - dk. brn, loose
80-37M
25 AUGUST 1980
SPT Blows/Ft MC LL PL % FINES
El 813.4
WL 807.1
El 777.2
Lt brn, m dense, dry, gravelly
Blk, clayey, m dense, wet
Gray, loose, sat, clayey
Gray, loose, sat, f-m sand
Olive grn, loose, sat, shell frags
Gray, loose, sat, f-c sand
Shells
Gray, loose, sat, f-c sand
Olive grn, loose, sat
Gray, soft - m stiff, plast, sat
Gray, m stiff, sl plast, till, f-m sand
81-62M
8-9 DECEMBER 1981
2x2½ SPT Blows/Ft MC LL PL % FINES
EL 818.7
Concrete
WL 811
El 744.7
Concrete base
Gravelly, sandy, silt, dk brn, moist, loose
Sandy, silty clay, brn, moist, med stiff
Clayey, brn, moist, med stiff
Gravelly, sandy, clayey silt, dk brn, sat, loose
Clayey, gray, wet, med stiff
Clayey, silty, sandy gravel, grayish brn, wet, dense
Silty sand, gray, sat, med dense
Clayey, silty, brn, wet, med dense, 7% gravel
Gravelly, sandy, silty clay, brn, wet, stiff, till
Gravelly, sandy silt, brn, wet, med dense
Very fine sand, f sand, lt brn, wet, dense, iron stained
Fine sand, lt brn, wet, dense
Gravelly sand, brn, sat, very dense
Very fine sand, lt brn, sat, very dense
Clayey silt, lt brn moist, very dense
Silty clay, gray, moist, hard
Sandy, silty clay, dk gray, moist, hard
Silty clay, dk gray, hard
Silty clay, dk gray, hard
81-63M
11-14 DECEMBER 1981
2x2½ SPT Blows/Ft MC LL PL % FINES
El 815.7
WL 811.7
El 757.2
Top soil, dk brn, moist, soft, roots
Gravelly, sandy silty clay, brn, moist, soft
Gravelly, silty clay, brn, wet, soft
Med grained sand, brn, wet, med dense
Sandy gravel, brn, sat, very dense

n, loose, dry – moist
v dense, sat, f gravel
v dense, sat, sandy, f gravel

m dense dry, gravelly
ayey, m dense, wet
ose, sat, clayey
ose, sat, f-m sand
rn, loose, sat, shell frags
ose, sat, f-c sand
ose, sat, f-c sand
n, loose, sat
ft - m stiff, plast, sat
stiff, sl plast, till, f-m sand

3M
MBER 1981

LL PL % FINES

Top soil
Gravelly, sandy ... moist, soft
Silty sand
38 17 36 Gravelly ... wet, soft
42 20 Sandy ... wet, very soft
Sandy ... loose

Gravelly, sandy ... brn wet

Clayey ... sat, med dense

Fine sand ... med dense

Med gr ... wet, med dense

Gravelly ... med dense

Sandy ... very dense

Sandy ...
Fine sand ...
Clayey ...
Very f... wet, very dense

Very fine ... wet, very dense
Sandy ... st, hard
Clayey ... very dense
Silty ... hard

80-34M
21-22 AUGUST 1980

SPT Blows/Ft	MC	LL	PL	% FINES	Soil	Description
					El 816.0 Conc	
9				9	SC	Brn, loose - m dense, moist
					SP-SM (WL 808.3)	Brn, m dense, moist - wet
23	13.9	30	12		GP	
18					CL	Gray, v stiff, sandy, sat, plast
38	14.3	35	16			
8				4	SP	Gray, loose, sat, 18% gravel
						Rough drilling
				1	GP	Gray, v. dense, c. gravel, sat
					SC (El 781.4)	Gray, m dense, sat

80-35M
22-23 AUGUST 1980

SPT Blows/Ft	MC	LL	PL	% FINES	Soil	Description
					El 814.9	
2	16.5	32	16		CL	Brn, sl plast, soft, wet, f gravel
9	18.7	36	13		(WL 806.7)	
7					SM	Gray, loose, sat, f-m sand
					CL	Gray, m stiff, silty, sl plast - plast, sat
10	15.8	31	14		CL	Gray, stiff - v stiff, plast, sandy, sat, f gravel
20						
15					El 785.2	

Elevation scale: 820, 810, 800, 790, 780, 770

80-38M
25 AUGUST 1980

SPT Blows/Ft	MC	LL	PL	% FINES	Soil	Description
					El 830.6 ML	Brn, m dense, dry, sandy
46		36	13	49	SC	Brn, v hard, moist, sl plast
21		44	15	55	SC	Lt brn, v stiff, moist, sl plast
105	72			25	CL	Moist, v dense
						Moist - wet
28	9.1			27	SM	Dk brn, m dense, 10% gravel
33						
16				24	El 801.7	

NOTE Water level not determined

80-39M
25-26 AUGUST 1980

SPT Blows/Ft	MC	LL	PL	% FINES	Soil	Description
				18	El 814.4 ML	Topsoil
3	18.6	28	13		SM	
5					CL	Gray, m stiff, v plastic, sat, sandy
11				4	SP	
				1	GM	Gray, m dense - dense, sat
28				3		37% gravel
29				6	SW	Brn, m dense, sat, 39% gravel
30					SW-SM (El 786.0)	

Elevation scale: 840, 830, 820, 810, 800, 790, 780

NOTE:
BORING LEGEND IS SHOWN ON SHEET NO C-11

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

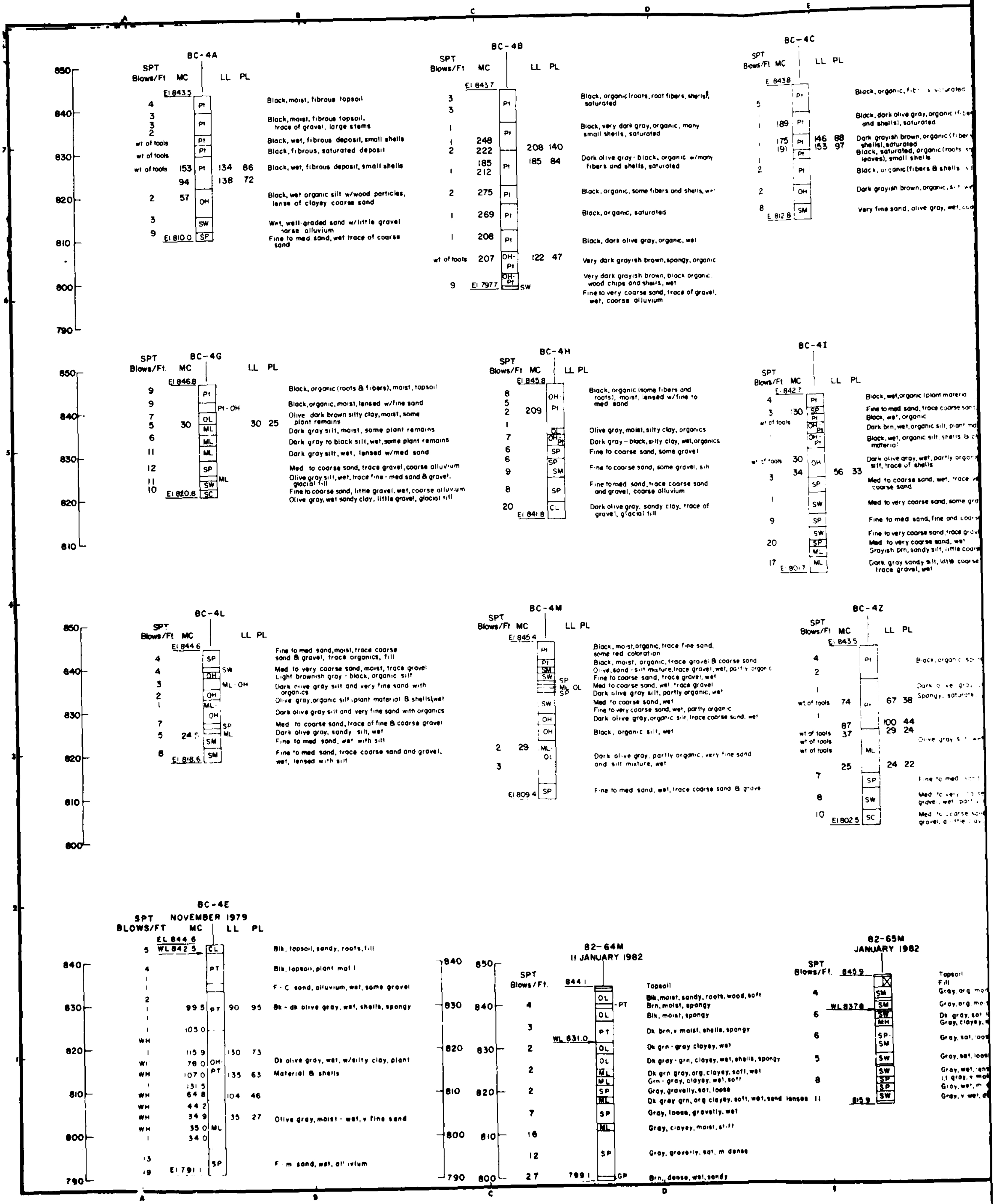
DESIGNED BY TMMB DWR
DRAWN BY JGJ, JMJ
CHECKED BY MB
SUBMITTED BY
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
FRUEN MILL AREA BORING LOGS
80-33M THRU 8-39M
80-53M, 81-62M, 81-63M

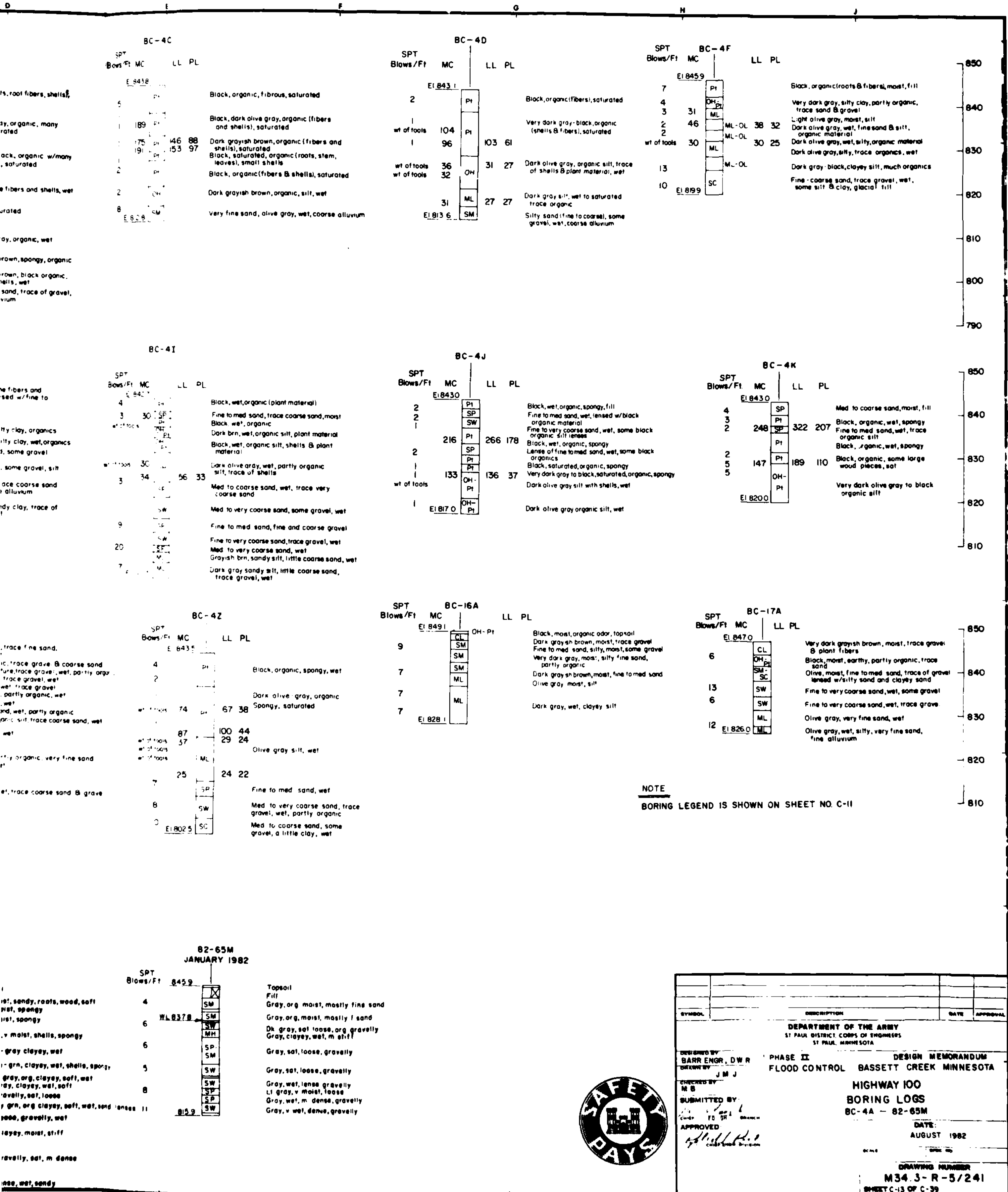
DATE: AUGUST 1982
SCALE AS SHOWN
DRAWING NUMBER M34.3-R-5/240
SHEET C-12 OF C-39

SAFETY PAYS

2



A
B
C
D
E
BC-4A
SPT Blows/Ft MC LL PL
El 843.5
Black, moist, fibrous topsoil
Black, moist, fibrous topsoil, trace of gravel, large stems
Black, wet, fibrous deposit, small shells
Black, fibrous, saturated deposit
Black, wet, fibrous deposit, small shells
Black, wet organic silt w/wood particles, lense of clayey coarse sand
Wet, well-graded sand w/little gravel coarse alluvium
Fine to med. sand, wet trace of coarse sand
El 810.0
BC-4B
SPT Blows/Ft MC LL PL
El 843.7
Black, organic (roots, root fibers, shells), saturated
Black, very dark gray, organic, many small shells, saturated
Dark olive gray - black, organic w/many fibers and shells, saturated
Black, organic, some fibers and shells, wet
Black, organic, saturated
Black, dark olive gray, organic, wet
Very dark grayish brown, spongy, organic
Very dark grayish brown, black organic, wood chips and shells, wet
Fine to very coarse sand, trace of gravel, wet, coarse alluvium
El 797.7
BC-4C
SPT Blows/Ft MC LL PL
El 843.8
Black, dark olive gray, organic
Dark grayish brown, organic
Black, saturated, organic
Very fine sand, olive gray, wet
El 812.8
BC-4G
SPT Blows/Ft. MC LL PL
El 846.8
Black, organic (roots & fibers), moist, topsoil
Black, organic, moist, lensed w/fine sand
Olive dark brown silty clay, moist, some plant remains
Dark gray silt, moist, some plant remains
Dark gray to black silt, wet, some plant remains
Dark gray silt, wet, lensed w/med sand
Med to coarse sand, trace gravel, coarse alluvium
Olive gray silt, wet, trace fine - med sand & gravel, glacial fill
Fine to coarse sand, little gravel, wet, coarse alluvium
Olive gray, wet sandy clay, little gravel, glacial till
El 820.8
BC-4H
SPT Blows/Ft MC LL PL
El 845.8
Black, organic (some fibers and roots), moist, lensed w/fine to med sand
Olive gray, moist, silty clay, organics
Dark gray - black, silty clay, wet, organics
Fine to coarse sand, some gravel
Fine to coarse sand, some gravel, silt
Fine to med sand, trace coarse sand and gravel, coarse alluvium
Dark olive gray, sandy clay, trace of gravel, glacial till
El 841.8
BC-4I
SPT Blows/Ft MC LL PL
El 842.7
Black, wet, organic (plant material)
Fine to med sand, trace coarse sand
Black, wet, organic
Dark brn, wet, organic silt, plant material
Black, wet, organic silt, shells
Dark olive gray, wet, partly organic silt, trace of shells
Med to coarse sand, wet, trace coarse sand
Med to very coarse sand, some gravel
Fine to med sand, fine and coarse
Fine to very coarse sand, trace gravel
Med to very coarse sand, wet
Grayish brn, sandy silt, little coarse
Dark gray sandy silt, little coarse, trace gravel, wet
BC-4L
SPT Blows/Ft MC LL PL
El 844.6
Fine to med sand, moist, trace coarse sand & gravel, trace organics, fill
Med to very coarse sand, moist, trace gravel
Light brownish gray - black, organic silt
Dark olive gray silt and very fine sand with organics
Olive gray, organic silt (plant material & shells) wet
Dark olive gray silt and very fine sand with organics
Med to coarse sand, trace of fine & coarse gravel
Dark olive gray, sandy silt, wet
Fine to med sand, wet with silt
Fine to med sand, trace coarse sand and gravel, wet, lensed with silt
El 818.6
BC-4M
SPT Blows/Ft MC LL PL
El 845.4
Black, moist, organic, trace fine sand, some red coloration
Black, moist, organic, trace gravel & coarse sand
Olive, sand - silt mixture, trace gravel, wet, partly organic
Fine to coarse sand, trace gravel, wet
Med to coarse sand, wet trace gravel
Dark olive gray silt, partly organic, wet
Med to coarse sand, wet
Fine to very coarse sand, wet, partly organic
Dark olive gray, organic silt, trace coarse sand, wet
Black, organic silt, wet
Dark olive gray, partly organic, very fine sand and silt mixture, wet
Fine to med sand, wet, trace coarse sand & gravel
El 809.4
BC-4Z
SPT Blows/Ft MC LL PL
El 843.5
El 802.5
BC-4E
NOVEMBER 1979
SPT BLOWS/FT MC LL PL
EL 844.6
WL 842.5
Blk, topsoil, sandy, roots, fill
Blk, topsoil, plant mat'l
F - C sand, alluvium, wet, some gravel
Bk - dk olive gray, wet, shells, spongy
Dk olive gray, wet, w/silty clay, plant material & shells
Olive gray, moist - wet, v fine sand
F - m sand, wet, alluvium
El 791.1
82-64M
11 JANUARY 1982
SPT Blows/Ft.
844.1
WL 831.0
Topsoil
Blk, moist, sandy, roots, wood, soft
Brn, moist, spongy
Blk, moist, spongy
Dk brn, v moist, shells, spongy
Dk grn - gray clayey, wet
Dk grdy - grn, clayey, wet, shells, spongy
Dk grn gray, org, clayey, soft, wet
Grn - gray, clayey, wet, soft
Gray, gravelly, sat, loose
Dk gray grn, org clayey, soft, wet, sand lenses
Gray, loose, gravelly, wet
Grey, clayey, moist, stiff
Gray, gravelly, sat, m dense
Brn, dense, wet, sandy
799.1
82-65M
JANUARY 1982
SPT Blows/Ft.
845.9
WL 837.9
815.9



NOTE
BORING LEGEND IS SHOWN ON SHEET NO. C-11

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

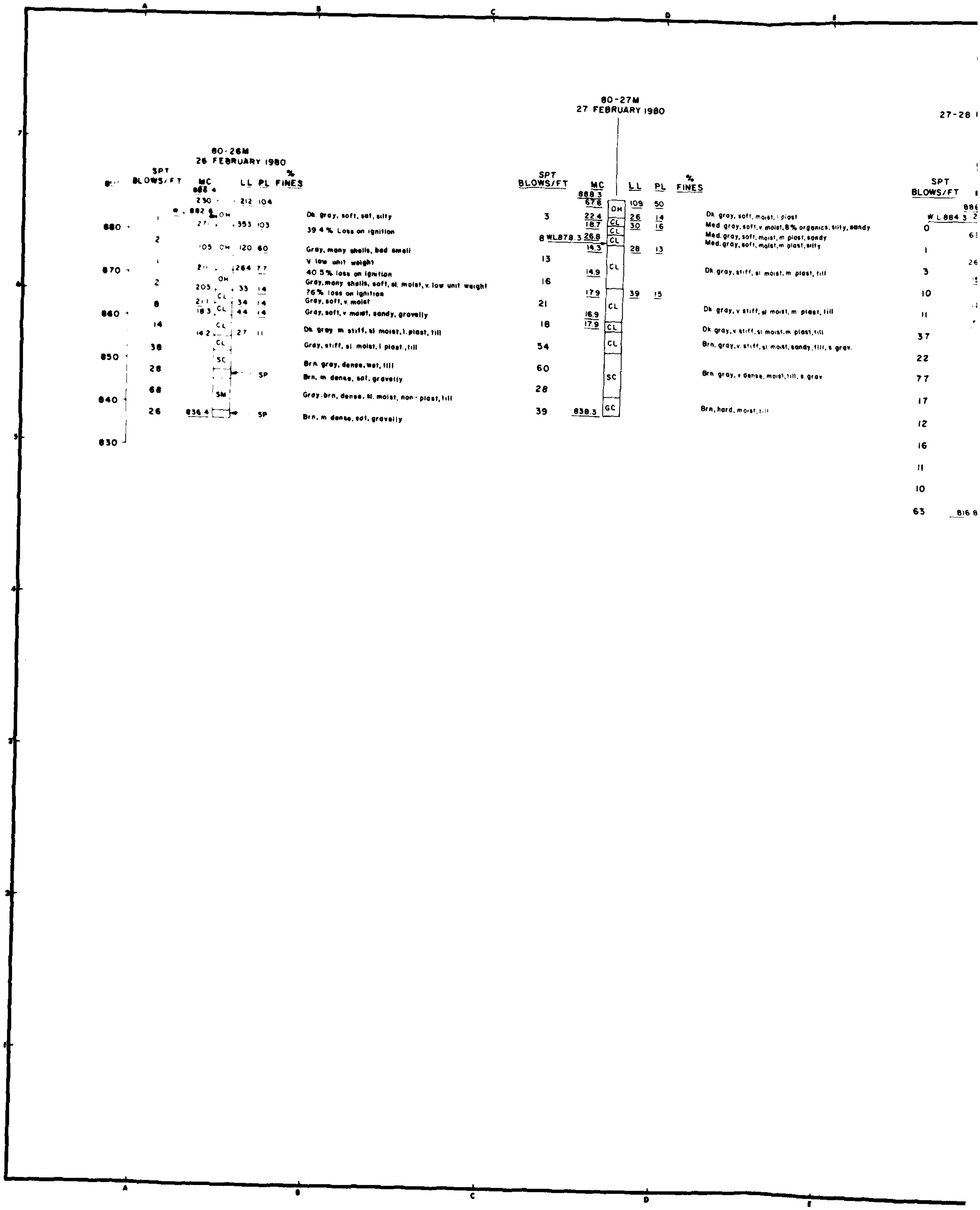
DESIGNED BY BARR ENGR., DWR
DRAWN BY J M J
CHECKED BY M B
SUBMITTED BY
APPROVED

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

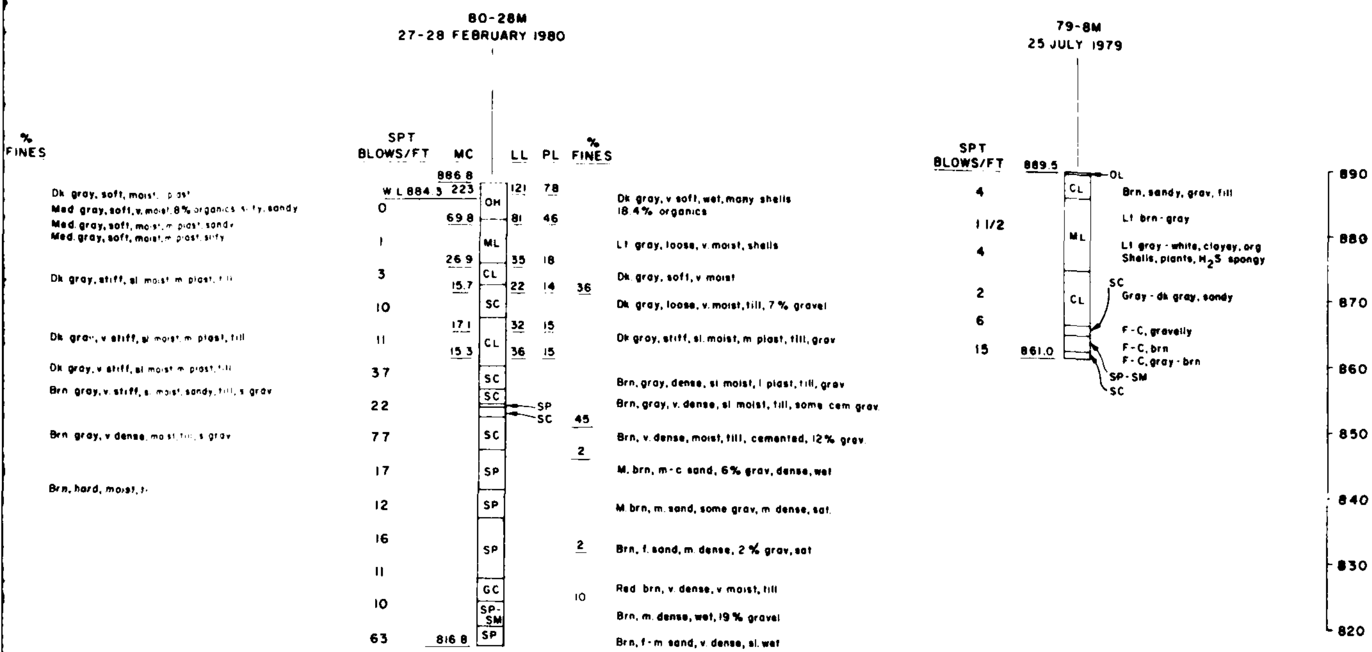
HIGHWAY 100
BORING LOGS
BC-4A — 82-65M

DATE: AUGUST 1982

DRAWING NUMBER
M34.3-R-5/241
SHEET C-13 OF C-39



80-26M
26 FEBRUARY 1980
SPT BLOWS/FT
MC
LL
PL
% FINES
880
870
860
850
840
830
Dk gray, soft, sat, silty
39 4 % Loss on ignition
Gray, many shells, bad smell
V low unit weight
40 5% loss on ignition
Gray, many shells, soft, sl. moist, v. low unit weight
76% loss on ignition
Gray, soft, v. moist
Gray, soft, v moist, sandy, gravelly
Dk gray m stiff, sl moist, l. plast, till
Gray, stiff, sl. moist, l plast., till
Brn. gray, dense, wet, till
Brn, m dense, sat, gravelly
Gray-brn, dense, sl. moist, non-plast, till
Brn, m dense, sat, gravelly
OH
CL
SC
SM
SP
836.4
80-27M
27 FEBRUARY 1980
SPT BLOWS/FT
MC
LL
PL
% FINES
888.3
WL 878.3
838.3
Dk gray, soft, moist, l plast
Med gray, soft, v moist, 8% organics, silty, sandy
Med. gray, soft, moist, m plast, sandy
Med. gray, soft, moist, m plast, silty
Dk. gray, stiff, sl moist, m plast, till
Dk gray, v stiff, sl moist, m plast, till
Dk gray, v stiff, sl moist, m plast, till
Brn. gray, v. stiff, sl moist, sandy, till, s grav.
Brn gray, v dense, moist, till, s. grav
Brn, hard, moist, till
OH
CL
SC
GC
27-28
SPT BLOWS/FT
W L 884.3
816 8
A
B
C
D
E



NOTE:
BORING LEGEND IS SHOWN ON SHEET NO. C-11

SYMBOL	DESCRIPTION	DATE	APPROVAL

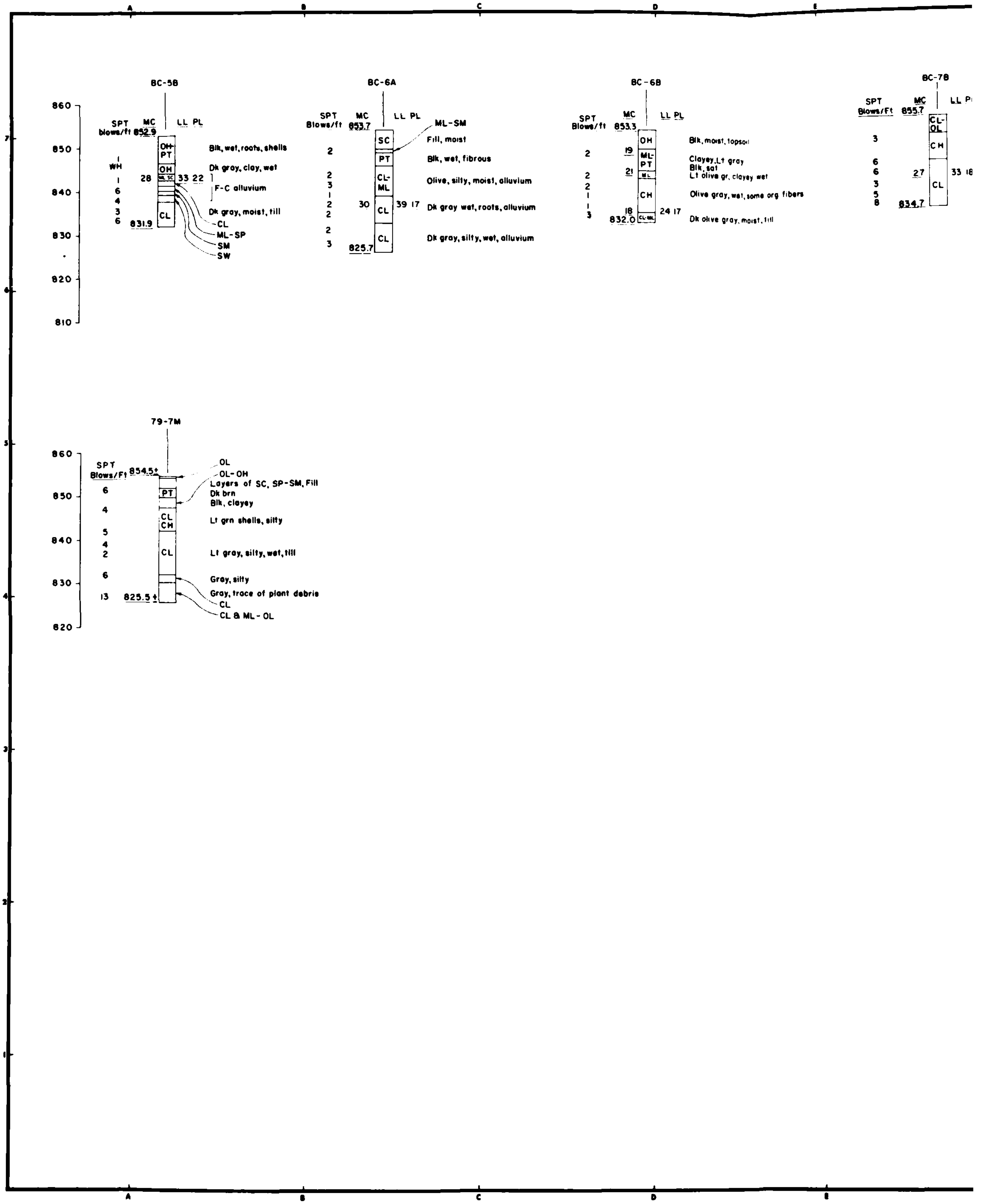
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: D.R
DRAWN BY: JGJ
CHECKED BY: DWR
SUBMITTED BY:
APPROVED:

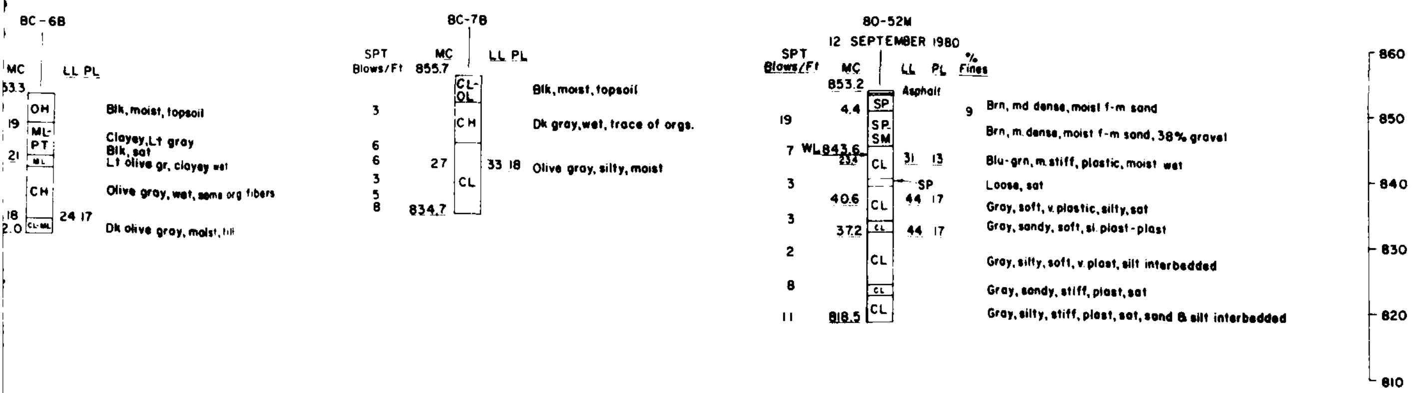
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

MEDICINE LAKE OUTLET
BORING LOGS

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER
M34.3-R-5/242
SHEET C-14 OF C-39



A
B
C
D
E
BC-5B
SPT blows/ft
MC
LL PL
852.9
OH
PT
OH
ML SC
CL
WH
28
33 22
831.9
Blk, wet, roots, shells
Dk gray, clay, wet
F-C alluvium
Dk gray, moist, till
CL
ML-SP
SM
SW
BC-6A
SPT Blows/ft
MC
LL PL
853.7
SC
PT
CL-ML
CL
30
39 17
825.7
ML-SM
Fill, moist
Blk, wet, fibrous
Olive, silty, moist, alluvium
Dk gray wet, roots, alluvium
Dk gray, silty, wet, alluvium
BC-6B
SPT Blows/ft
MC
LL PL
853.3
OH
ML-PT
ML
CH
CL-ML
19
21
18
24 17
832.0
Blk, moist, topsoil
Clayey, Lt gray
Blk, sat
Lt olive gr, clayey wet
Olive gray, wet, some org fibers
Dk olive gray, moist, till
BC-7B
SPT Blows/Ft
MC
LL PL
855.7
CL-OL
CH
CL
27
33 18
834.7
860
850
840
830
820
810
79-7M
SPT Blows/Ft
854.5±
825.5±
PT
CL
CH
CL
OL
OL-OH
Layers of SC, SP-SM, Fill
Dk brn
Blk, clayey
Lt grn shells, silty
Lt gray, silty, wet, till
Gray, silty
Gray, trace of plant debris
CL
CL & ML-OL



NOTE:
BORING LEGEND IS SHOWN ON SHEET NO. C-11

SYMBOL	DESCRIPTION	DATE	APPROVAL

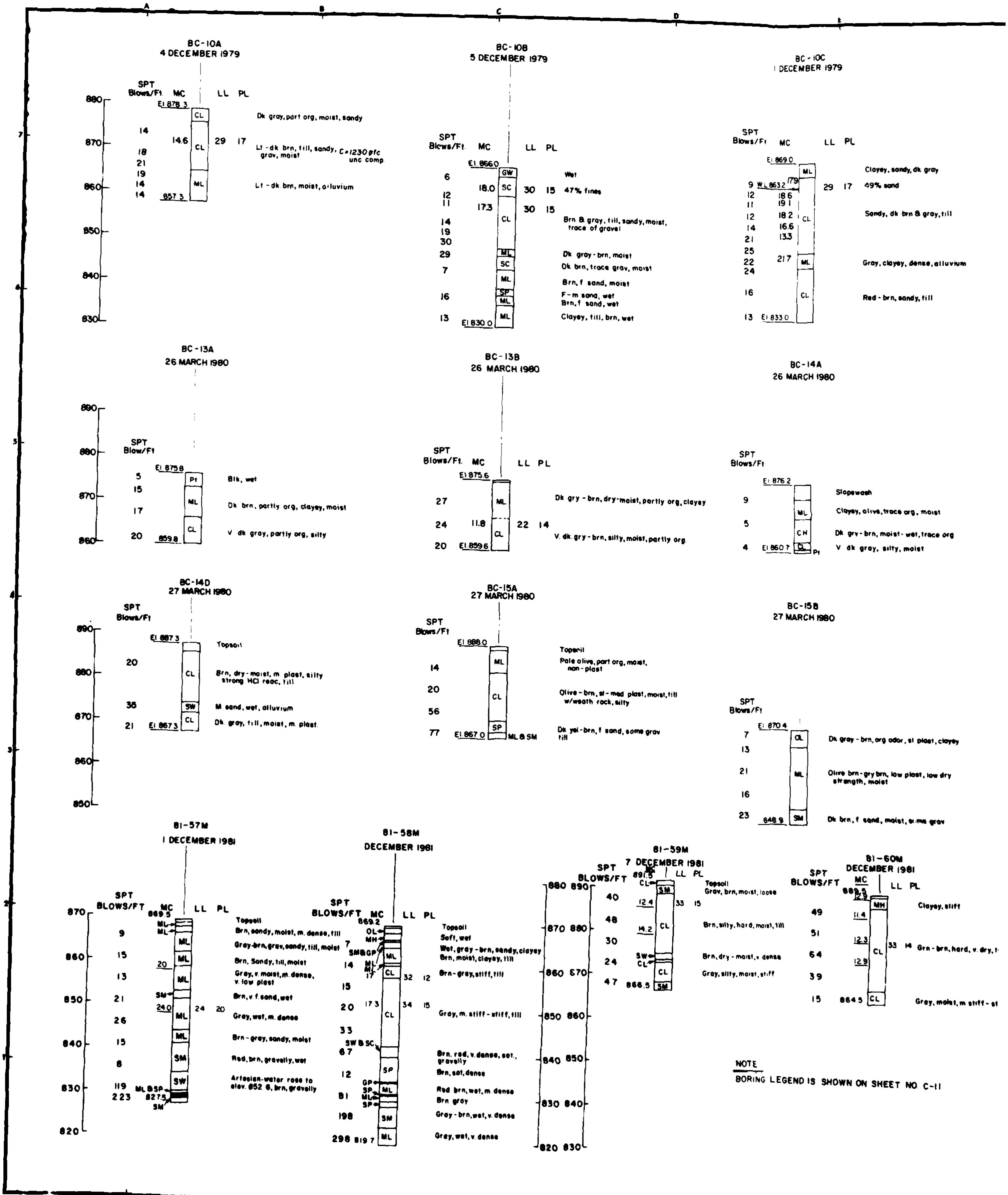
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: D W R
DRAWN BY: C R C
CHECKED BY: D.W.R.
SUBMITTED BY:
APPROVED:

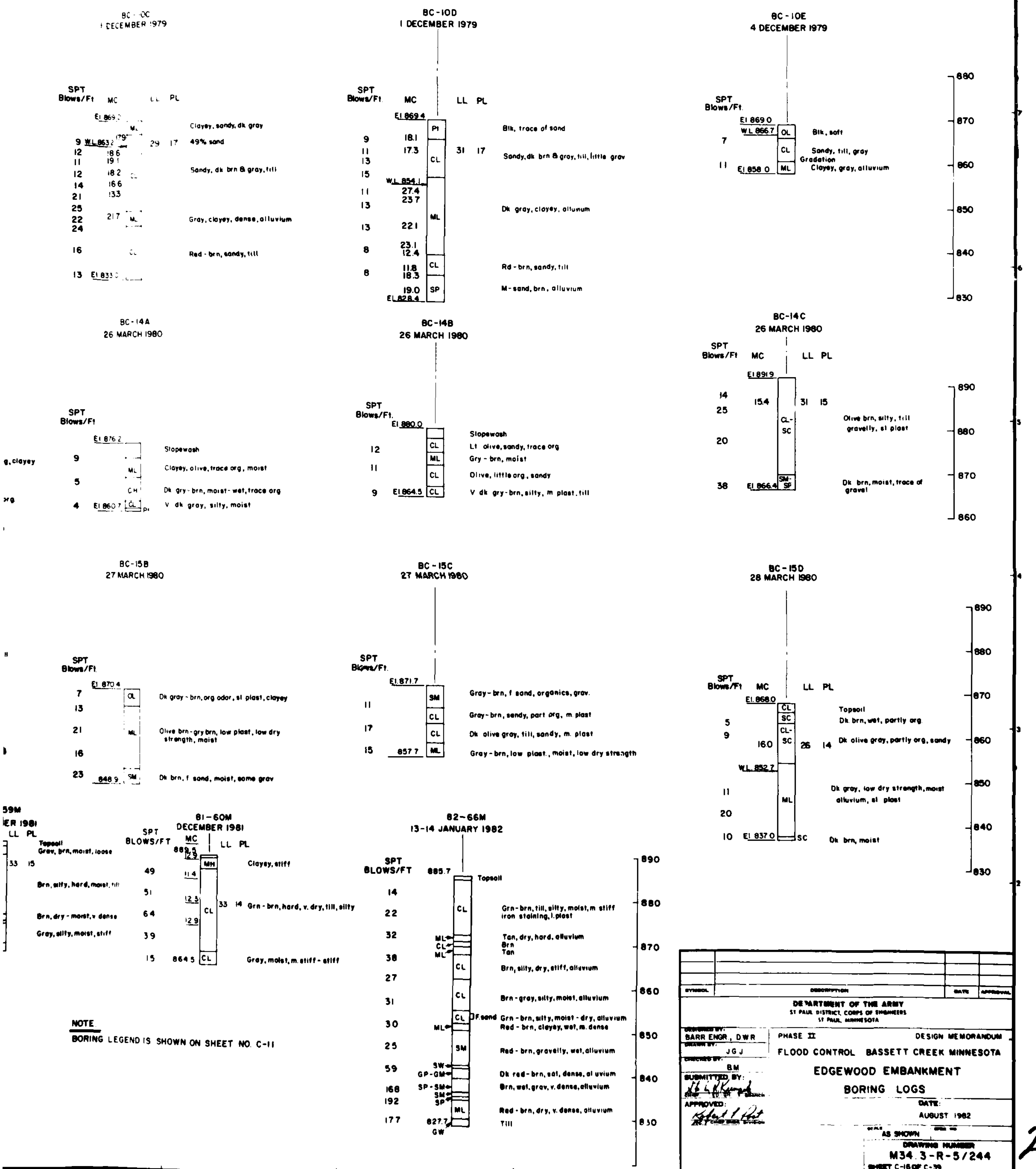
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
BORING LOGS @ BRUNSWICK
AND 32 AVES

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER: M34.3-R-5/243
SHEET C-15 OF C-39

2



NOTE
BORING LEGEND IS SHOWN ON SHEET NO. C-11



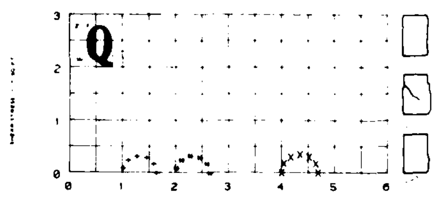
NOTE
BORING LEGEND IS SHOWN ON SHEET NO. C-11

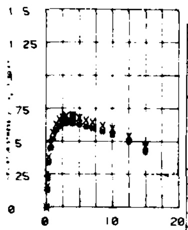
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY: BARR ENGR., DWR
DRAWN BY: JGJ
CHECKED BY: BM
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
EDGEWOOD EMBANKMENT
BORING LOGS

DATE: AUGUST 1982
SCALE: AS SHOWN
DRAWING NUMBER
M34.3-R-5/244
SHEET C-16 OF C-39





SPECIMEN NO.		1	2	3
Initial: Water content	%	95.5	78.2	75.0
Dry density, lb/cu ft		60.2	67.0	67.
Saturation	%	100.	100.	100.
Void ratio		1.79	1.01	1.00
Before shear: Water content	%	78.1	78.5	72.9
Dry density, lb/cu ft		60.2	67.0	67.
Saturation	%	100.	100.	100.
Void ratio		1.79	1.01	1.00
Back pressure, T/sq ft		0.	0.	0.
Minor principal stress, T/sq ft		1.	2.	4.
Maximum deviator stress, T/sq ft		.84	.845	.900
Time to failure		0	0	0
Ultimate deviator stress, T/sq ft		.479	.421	.405
Initial diameter	in.	1.4	1.4	1.4
Initial height	in.	2.97	2.97	2.99

CONTROLLED: STRAIN

G 2.8

TYPE OF SPECIMEN: UNDISTURBED — TYPE OF TEST: Q

PROJECT: BABBETT CREEK NCS-IA-88-88-CD-HF

BORING NO. 79-14 MU — SAMPLE NO. 2

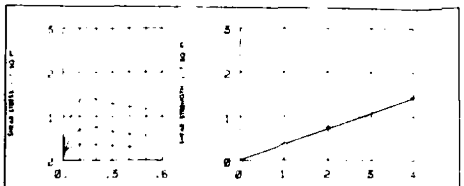
DEPTH 24.0-25.9

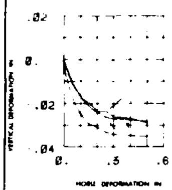
LAB NO. 88/128 — DATE 27 MAY 1980

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM 2089 — TRANSLUCENT

Figure 1





SHEAR STRENGTH PARAMETERS

S

CONTROLLED STRESS

[X] CONTROLLED STRAIN

TEST NO.		1	2	3
Initial: Water content	%	57.9	55.5	60.0
Void ratio		1.40	1.47	1.58
Saturation	%	100.	90.	100.
Dry density, lb/cu ft		66.4	65.7	64.1
Void ratio after consolidation		1.59	1.26	1.
Time for 50 percent consolidation, min				
Final: Water content	%	50.7	52.4	40.0
Void ratio		1.26	1.09	.86
Saturation	%	100.	100.	100.
Normal stress, T/sq ft		1.	2.	4.
Maximum shear stress, T/sq ft		.57	.76	1.45
Actual time to failure, min		500	420	420
Rate of strain, in./min		.0001		
Ultimate shear stress, T/sq ft		.28	.56	1.16

TYPE OF SPECIMEN: UNDISTURBED — 3. IN SQUARE — .586 IN THICK

CLASSIFICATION

G 2.8

REMARKS

PROJECT: BABBETT CREEK NCS-IA-88-88-CD-HF

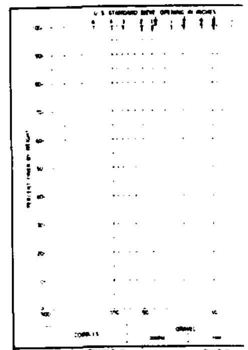
AREA: MRD LAB NO: 88/128

BORING NO. 79-14 MU — SAMPLE NO. U-2

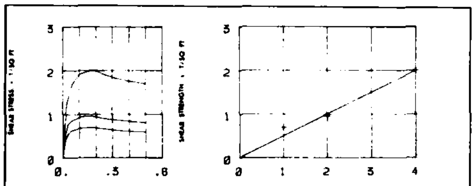
DEPTH, ft 24.0-25.9 — DATE 27 MAY 1980

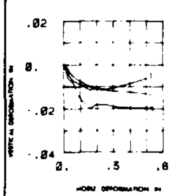
DIRECT SHEAR TEST REPORT

ENG FORM 2092, 1 JUN 65 — PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT — PLATE NO. 1



ENG FORM 2087





SHEAR STRENGTH PARAMETERS

S

CONTROLLED STRESS

[X] CONTROLLED STRAIN

TEST NO.		1	2	3
Initial: Water content	%	52.0	51.	28.7
Void ratio		1.01	.95	.85
Saturation	%	87.	90.	95.
Dry density, lb/cu ft		85.9	87.5	91.9
Void ratio after consolidation		.98	.87	.75
Time for 50 percent consolidation, min				
Final: Water content	%	34.9	32.4	28.9
Void ratio		.92	.82	.88
Saturation	%	100.	100.	100.
Normal stress, T/sq ft		1.	2.	4.
Maximum shear stress, T/sq ft		.7	.98	2.01
Actual time to failure, min		540	510	750
Rate of strain, in./min		.0001		
Ultimate shear stress, T/sq ft		.59	.8	1.7

TYPE OF SPECIMEN: UNDISTURBED — 3. IN SQUARE — .588 IN THICK

CLASSIFICATION

G 2.7

REMARKS

PROJECT: BABBETT CREEK NCS-IA-88-88-CD-HF

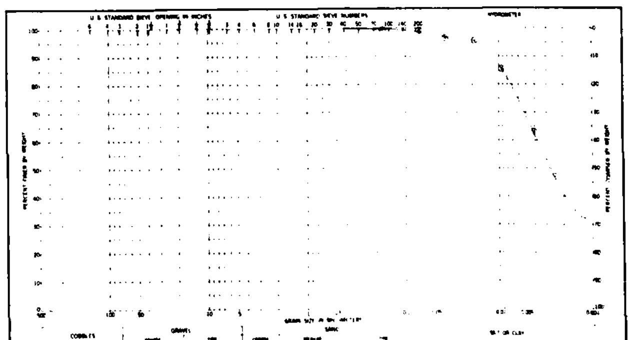
AREA: MRD LAB NO: 88/128

BORING NO. 80-10 MU — SAMPLE NO. 1

DEPTH, ft 10.0-17.0 — DATE 27 MAY 1980

DIRECT SHEAR TEST REPORT

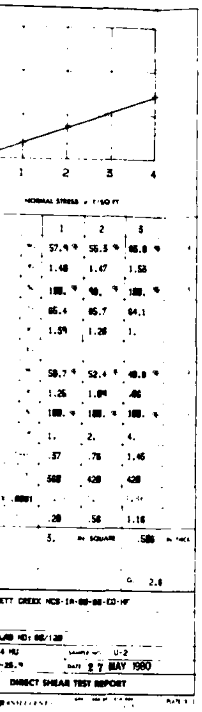
ENG FORM 2092, 1 JUN 65 — PREVIOUS EDITIONS ARE OBSOLETE — TRANSLUCENT — PLATE NO. 3

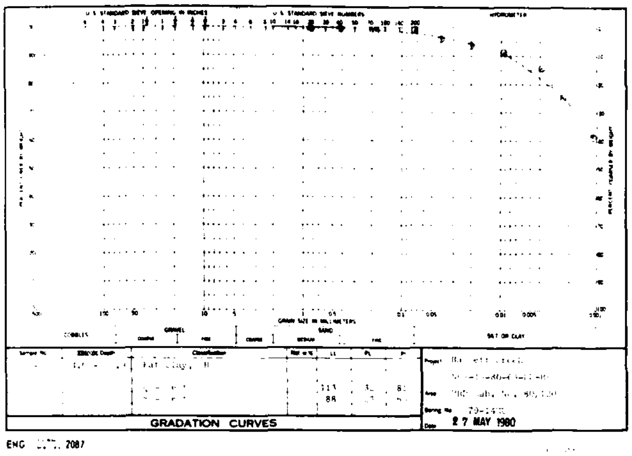


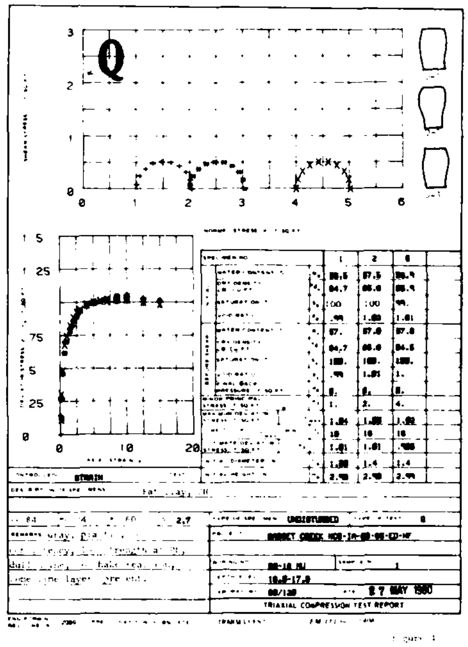
Sample No.	Elev or Depth	Classification

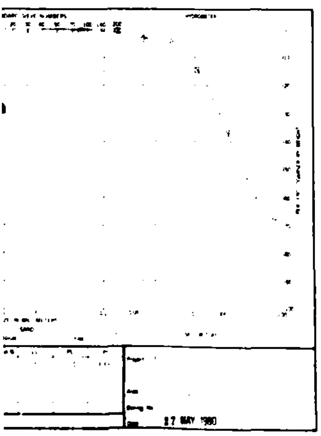
GRADATION CURVES — DATE 27 MAY 1980

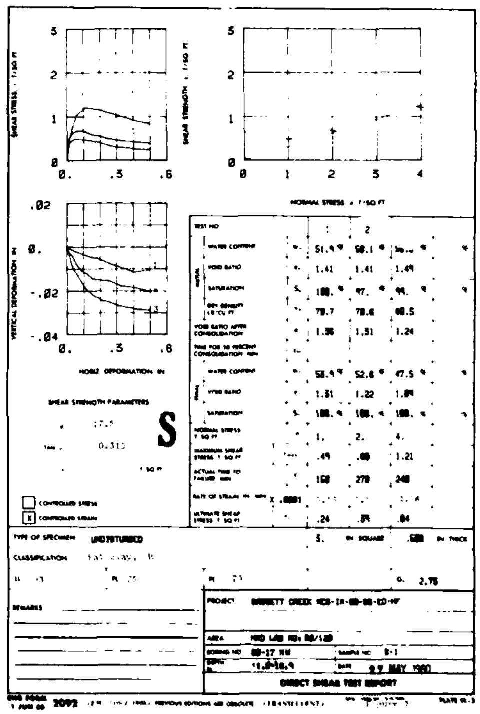
ENG FORM 2087

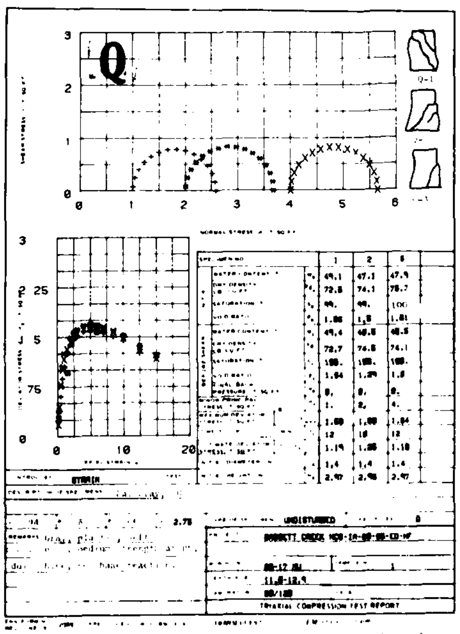












SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
TUNNEL ALIGNMENT
BORINGS 79-14MU, 80-16MU & 80-17MU

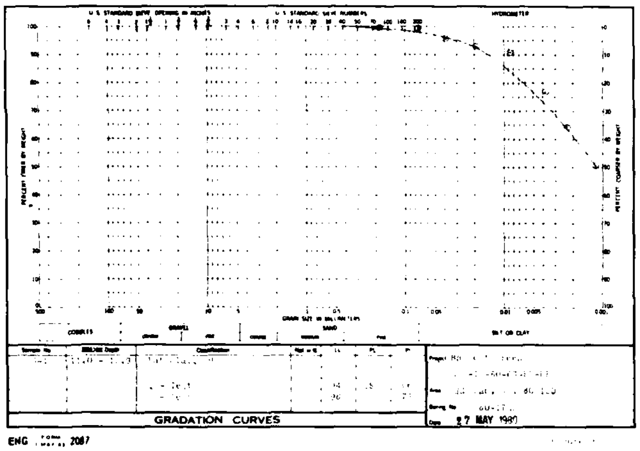
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

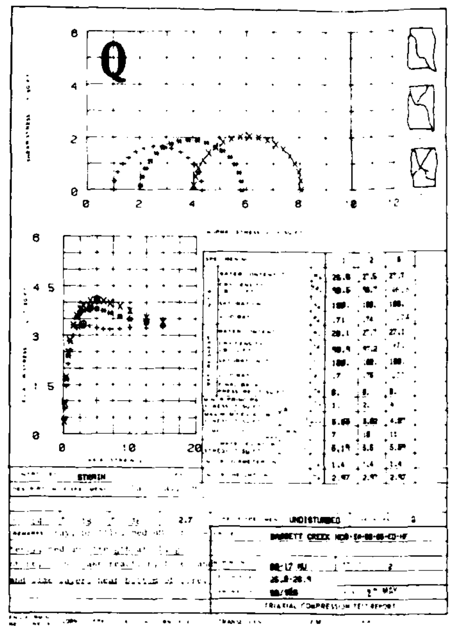
DATE: AUGUST 1982

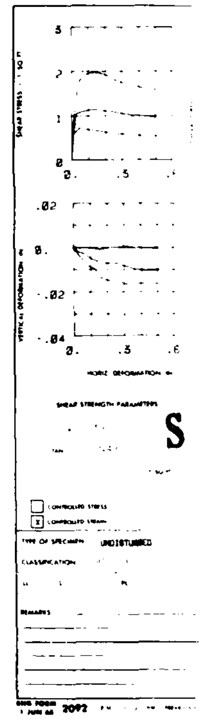
SCALE:
SPEC NO.

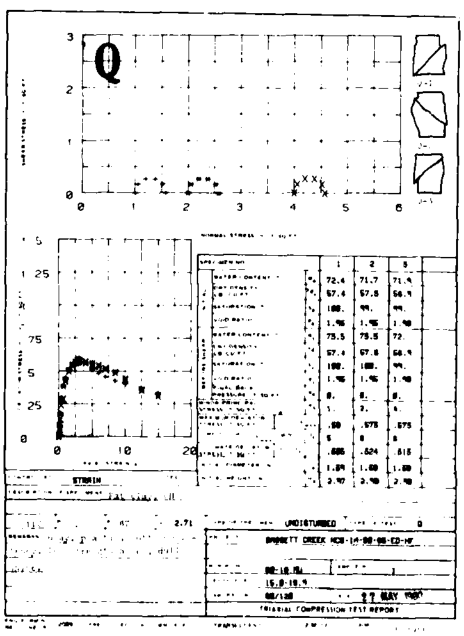
DRAWING NUMBER
M34.3-R-5/245
SHEET C-17 OF C-39

2


GRADATION CURVES
ENG 2087
27 MAY 1987


Q
STRAIN
UNDISTURBED
BABBETT CREEK NCB-IA-88-88-ED-HF
2.7
TRIAXIAL COMPRESSION TEST REPORT


S
SHEAR STRENGTH PARAMETERS
CONTROLLED STRESS
CONTROLLED STRAIN
UNDISTURBED
CLASSIFICATION
REMARKS
ENG FORM 2092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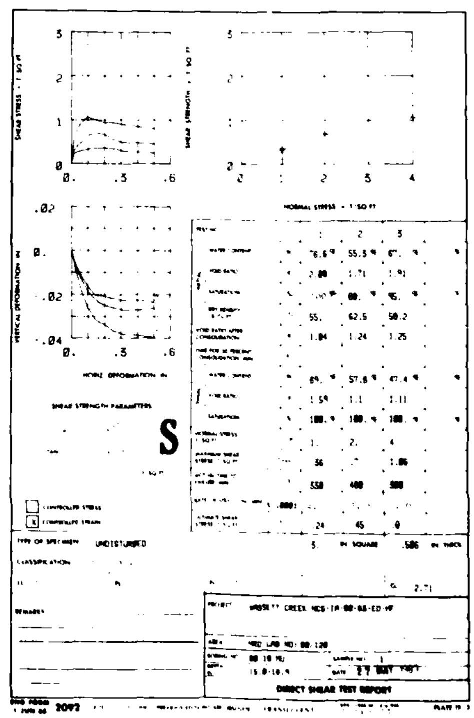
BABBETT CREEK NCB-IA-88-88-ED-HF
2.71
27 MAY 1987
TRIAXIAL COMPRESSION TEST REPORT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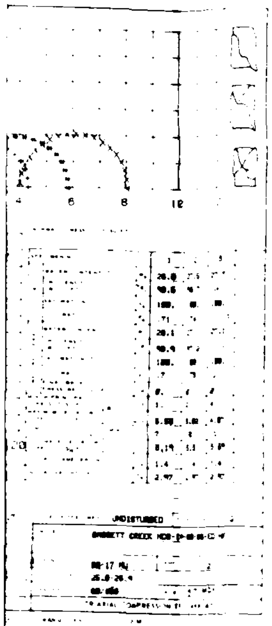
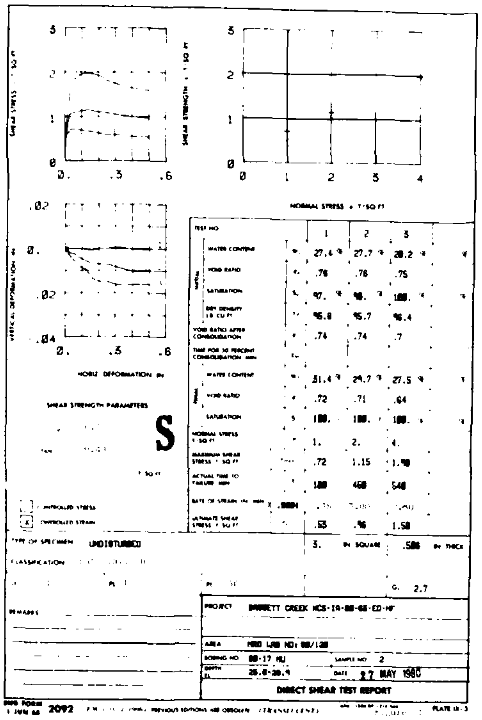
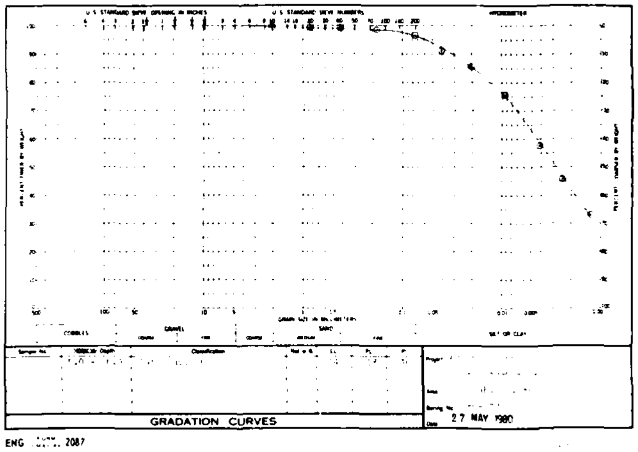
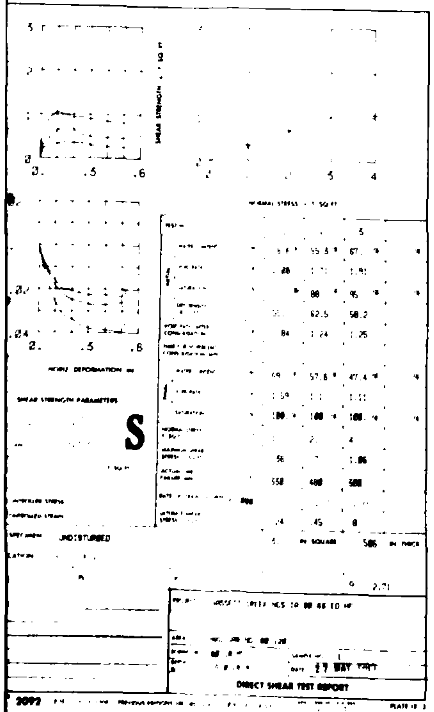
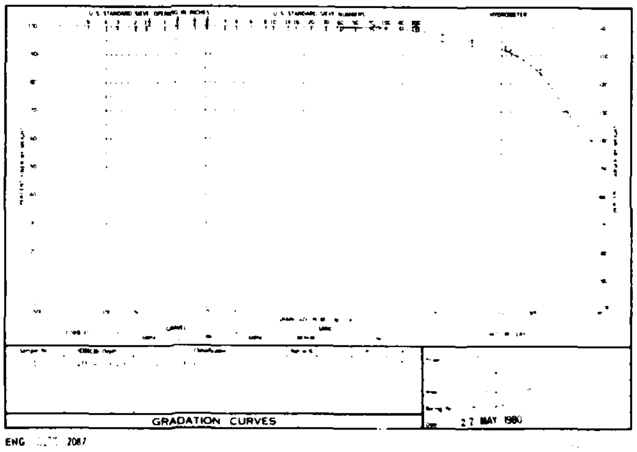
SHEAR STRENGTH PARAMETERS
HORIZ DEFORMATION IN
CONTROLLED STRESS
CONTROLLED STRAIN
TYPE OF SPECIMEN UNDISTURBED
CLASSIFICATION
REMARKS
2.71
27 MAY 1987
DIRECT SHEAR TEST REPORT
ENG FORM 2092











SAFETY PAYS

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
APPROVED

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
TUNNEL ALIGNMENT
BORINGS 80-17MU & 80-18MU

DATE: AUGUST 1982

DRAWING NUMBER
M34.3-R-5/246
SHEET C-18 OF C-39

2

A B C D E

SOIL CLASSIFICATION RECORD SHEET

Project		Boring No	MRD Lab No
Station	Range	Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) L L	Plasticity (Att Limits) P I	Grading (Cumulative Percents Finer)	Gradation Curve Analysis C_u	C_c	Classification Tech MEMO 3-357, May 67	Remarks
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

Project		Boring No	MRD Lab No
Station	Range	Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) L L	Plasticity (Att Limits) P I	Grading (Cumulative Percents Finer)	Gradation Curve Analysis C_u	C_c	Classification Tech MEMO 3-357, May 67	Remarks
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

Project		Boring No	MRD Lab No
Station	Range	Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) L L	Plasticity (Att Limits) P I	Grading (Cumulative Percents Finer)	Gradation Curve Analysis C_u	C_c	Classification Tech MEMO 3-357, May 67	Remarks
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		

MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE

A B C D E

SOIL CLASSIFICATION RECORD SHEET

Project			Boring No	MRD Lab No
Station	Range	Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) LL	PI	Grading (Cumulative Percents Finer)	Gradation Curve Analysis Cu	Cc	Classification Tech MEMO 3-357, May 67	Remarks

MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE

SOIL CLASSIFICATION RECORD SHEET

Project			Boring No	MRD Lab No
Station	Range	Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) LL	PI	Grading (Cumulative Percents Finer)	Gradation Curve Analysis Cu	Cc	Classification Tech MEMO 3-357, May 67	Remarks

MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
CHIEF BRANCH
APPROVED
CHIEF ENGR DIVISION

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
TUNNEL, FRUENMILL, HWY 55 CONTROL STRUCTURE
BORINGS 80-15M TO 80-22M & 80-28M TO 80-44M

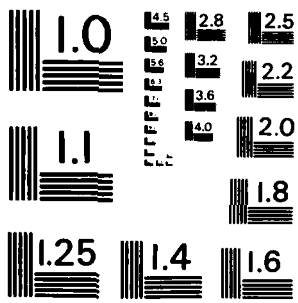
DATE
AUGUST 1982

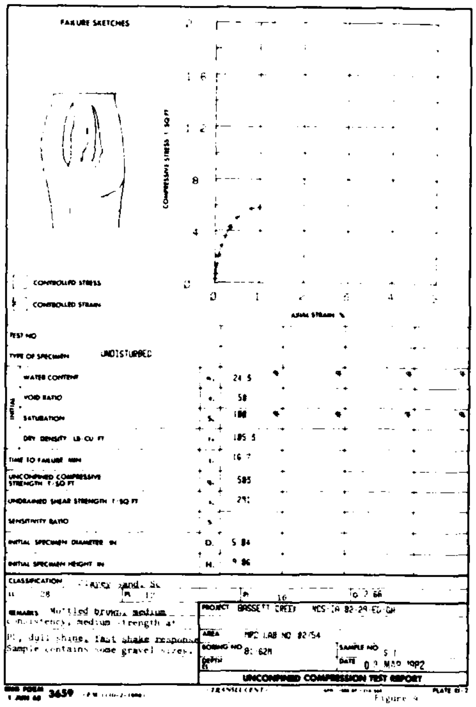
SCALE
DRAWING NUMBER
M34.3-R-5/247
SHEET 9 OF 10

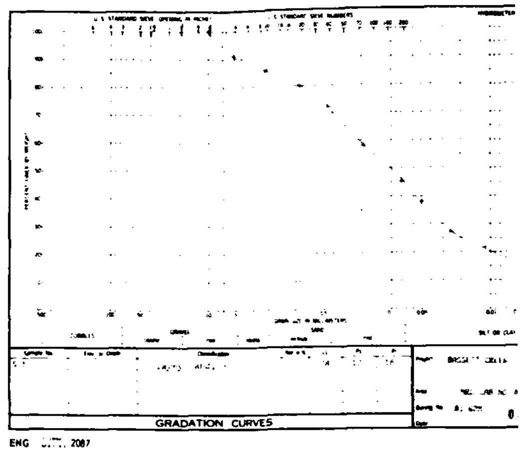
SAFETY PAYS

AD-A133 795 BASSETT CREEK WATERSHED HENNEPIN COUNTY MINNESOTA FEASIBILITY REPORT FOR FLOOD CONTROL MAIN REPORT(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 82 4/7

UNCLASSIFIED F/G 13/2 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6


FAILURE SKETCHES
COMPRESSIVE STRESS, T/SQ FT
AXIAL STRAIN, %
CONTROLLED STRESS
CONTROLLED STRAIN
TEST NO
TYPE OF SPECIMEN UNDISTURBED
WATER CONTENT 24.5
VOID RATIO .58
SATURATION 100
DRY DENSITY, LB/CU FT 105.5
TIME TO FAILURE, MIN
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT .585
UNDRAINED SHEAR STRENGTH, T/SQ FT .292
SENSITIVITY RATIO
INITIAL SPECIMEN DIAMETER, IN 5.84
INITIAL SPECIMEN HEIGHT, IN 9.86
CLASSIFICATION Clayey sand, SC
REMARKS Mottled brown, medium consistency, medium strength at PL, dull shine, fast shake response. Sample contains some gravel sizes.
PROJECT BASSETT CREEK
AREA MPC LAB NO 82/54
BORING NO B1-62M
SAMPLE NO S-1
DATE 03 MAR 1982
UNCONFINED COMPRESSION TEST REPORT
ENG FORM 1 JUN 66 3659
Figure 9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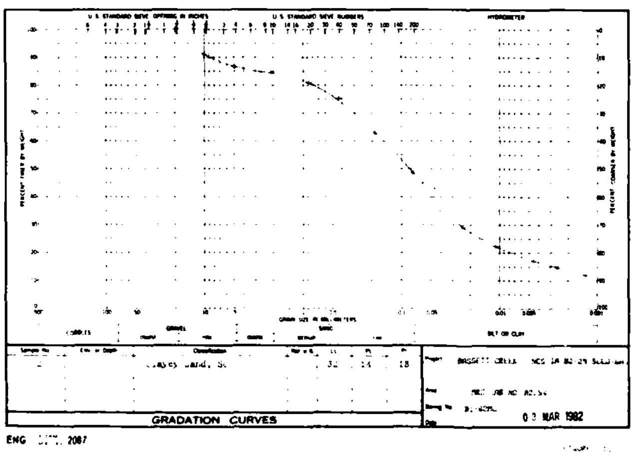
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT FINER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
BASSETT CREEK
GRADATION CURVES
ENG FORM 2087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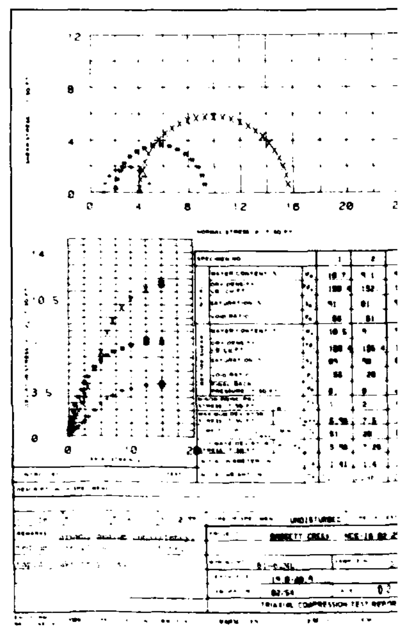
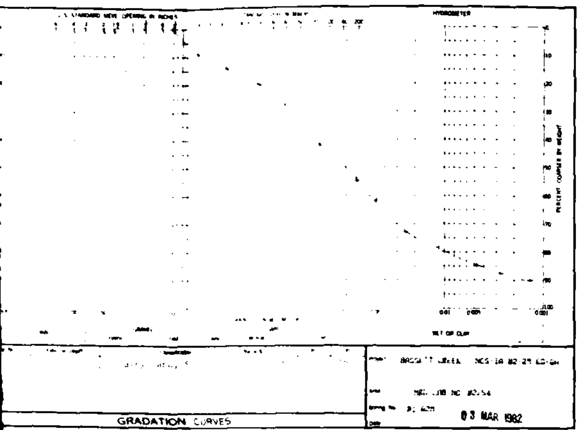
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
Clayey sand, SC
BASSETT CREEK
MPC LAB NO 82/54
03 MAR 1982
GRADATION CURVES
ENG FORM 2087


UNDISTURBED
BASSETT CREEK
TRIAXIAL COMPRESSION TEST REPORT



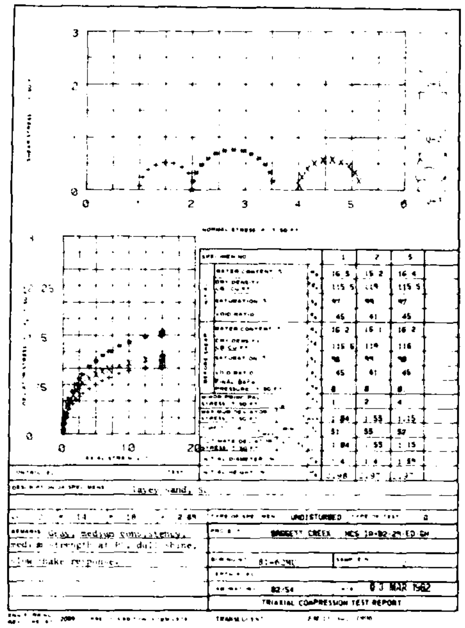
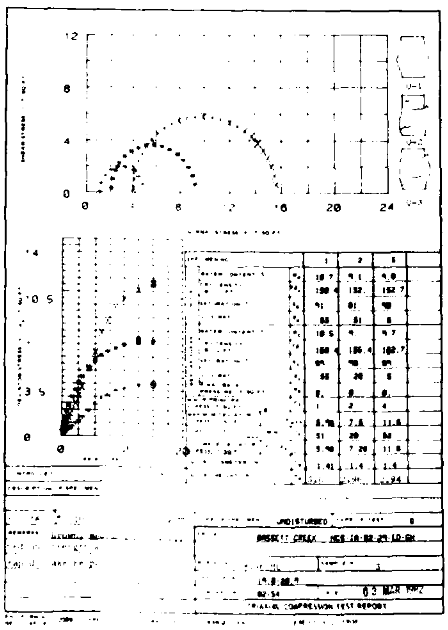
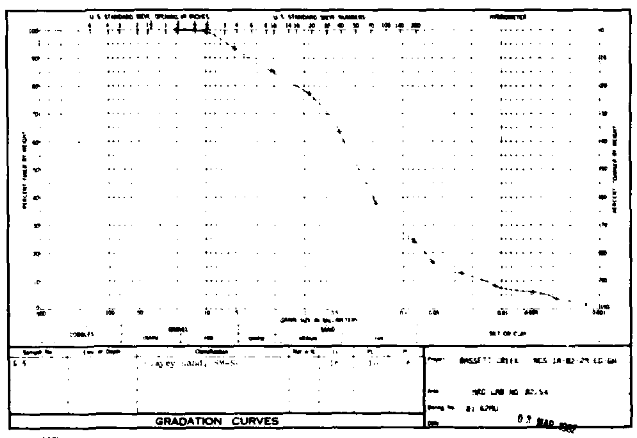


Figure 11





SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
FRUEN MILL BRIDGE
BORING 81-62MU

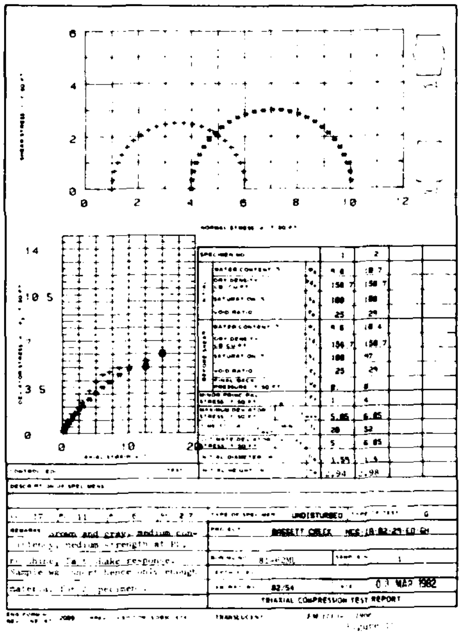
DATE
AUGUST 1982

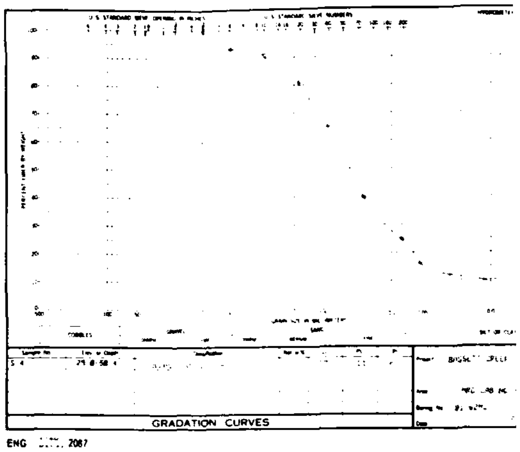
SCALE

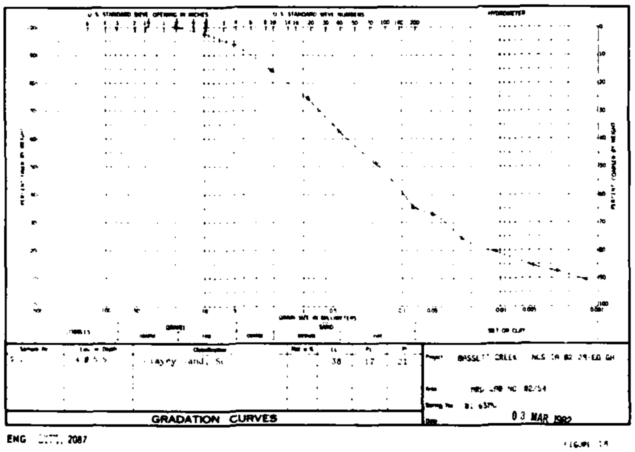
DRAWING NUMBER
M34.3-R-5/248

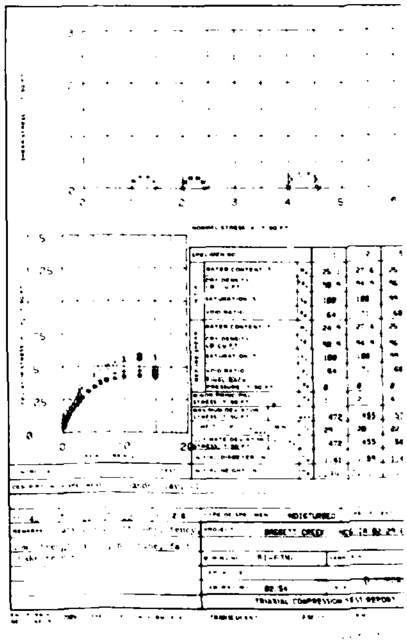
SHEET 20 OF 39

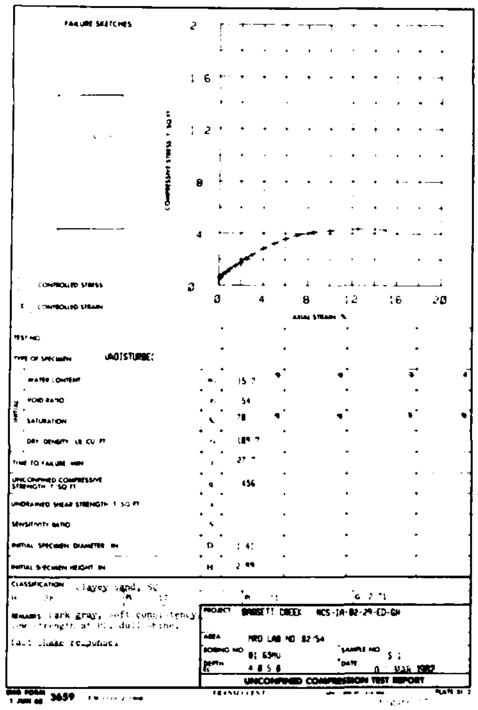
2

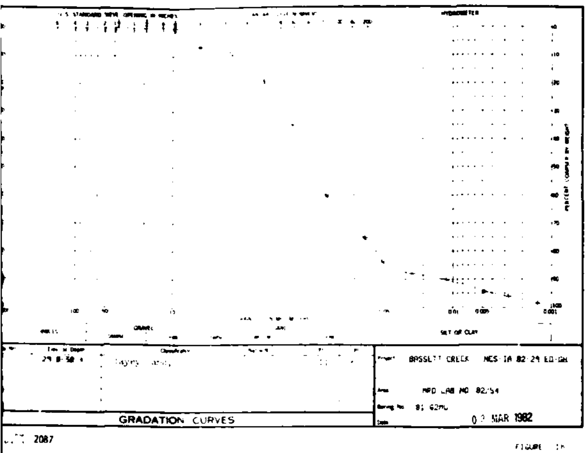

UNDISTURBED
BASSETT CREEK
03 MAR 1982
TRIAXIAL COMPRESSION TEST REPORT

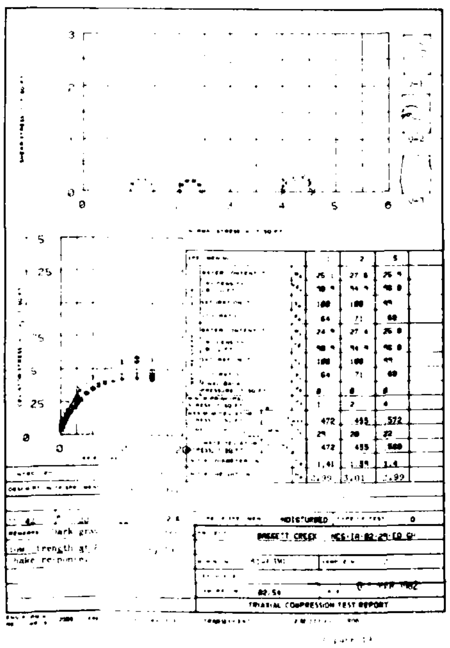

GRADATION CURVES
ENG 2087

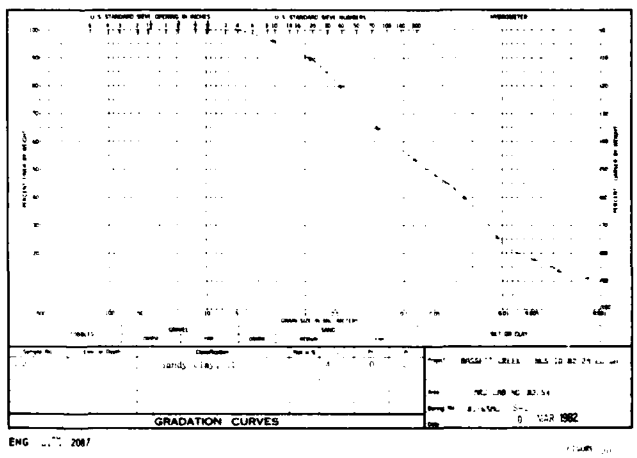

U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
GRAIN SIZE IN MILLIMETERS
BASSETT CREEK
03 MAR 1982
GRADATION CURVES
ENG 2087


UNDISTURBED
BASSETT CREEK
TRIAXIAL COMPRESSION TEST REPORT









SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA

FRUEN MILL BRIDGE
BORINGS 81-62MU & 81-63MU

DATE: AUGUST 1982

SCALE:
DRAWING NUMBER
M34.3-R-5/249
SHEET O-21 OF O-39

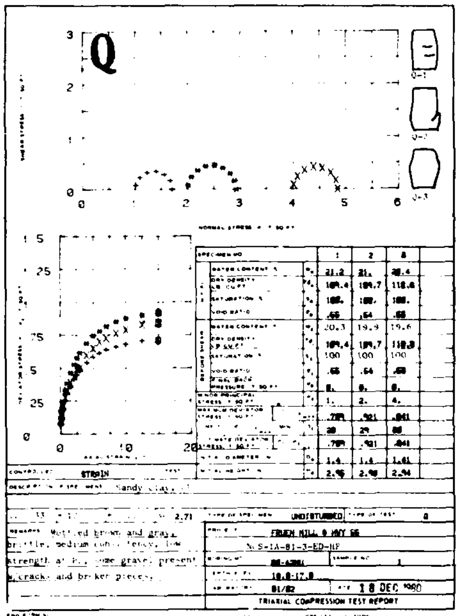
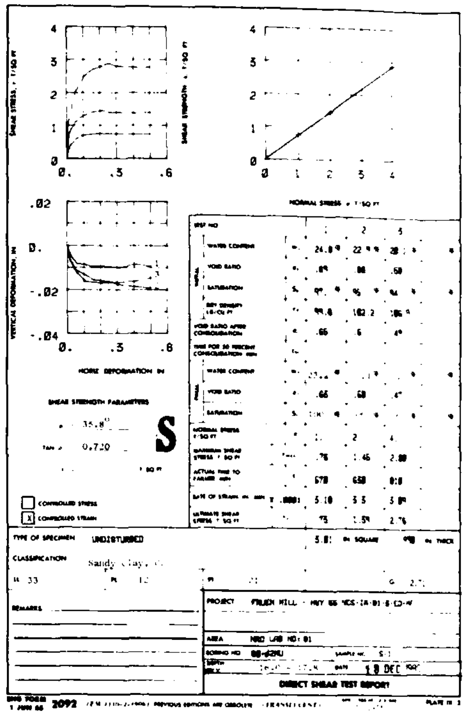
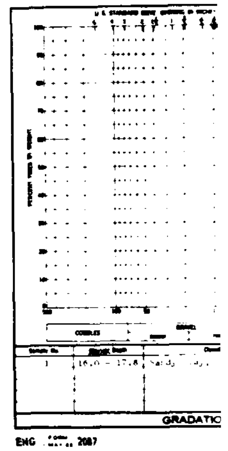
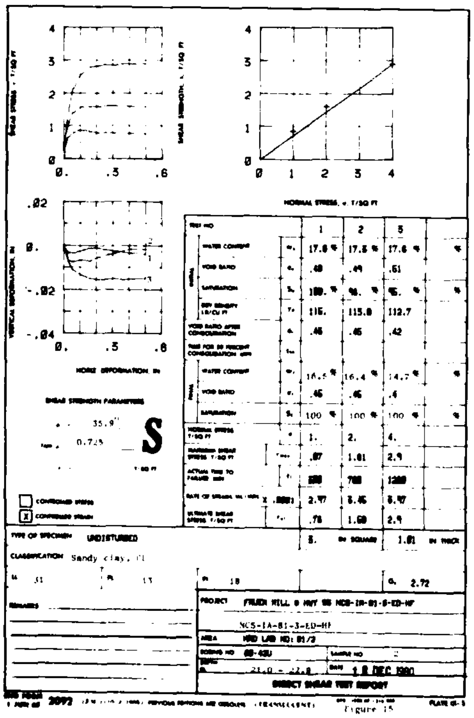


Figure 11







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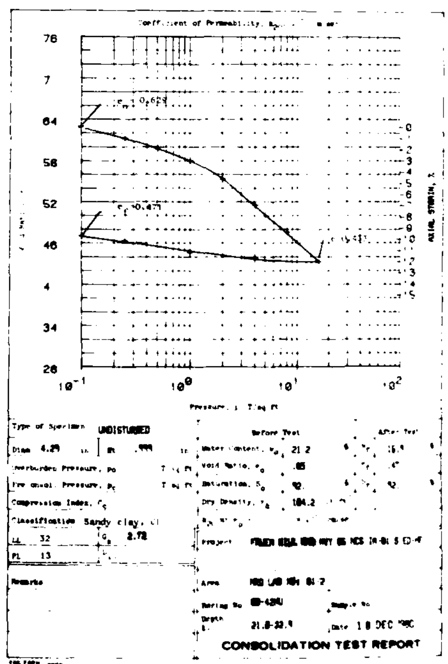
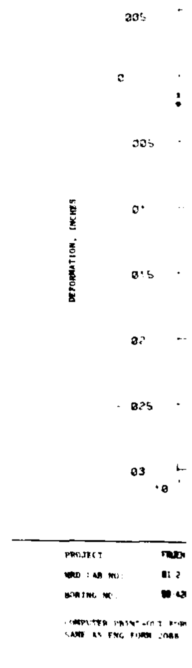
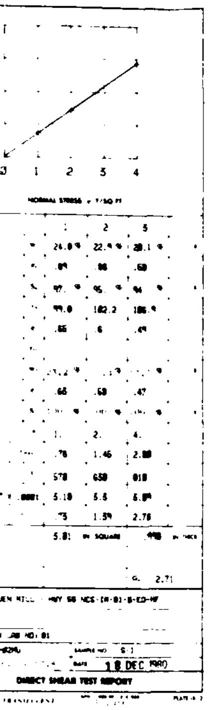
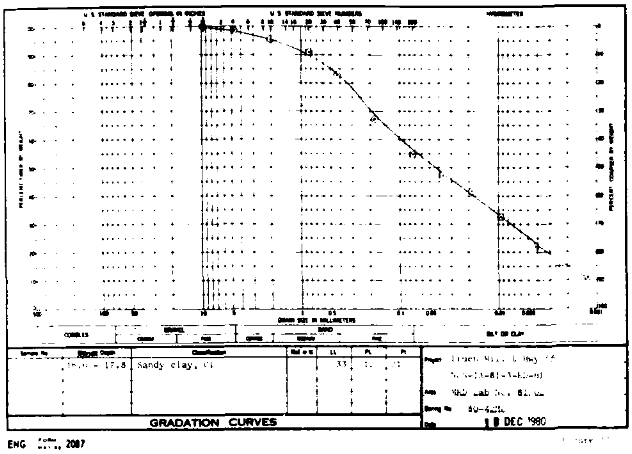
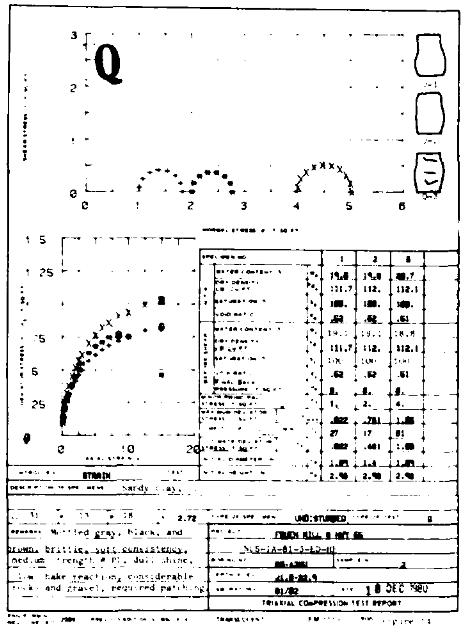
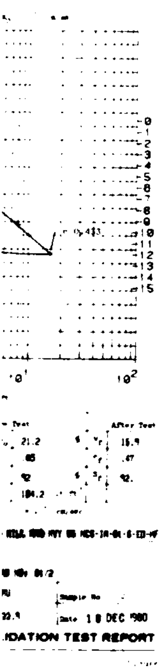


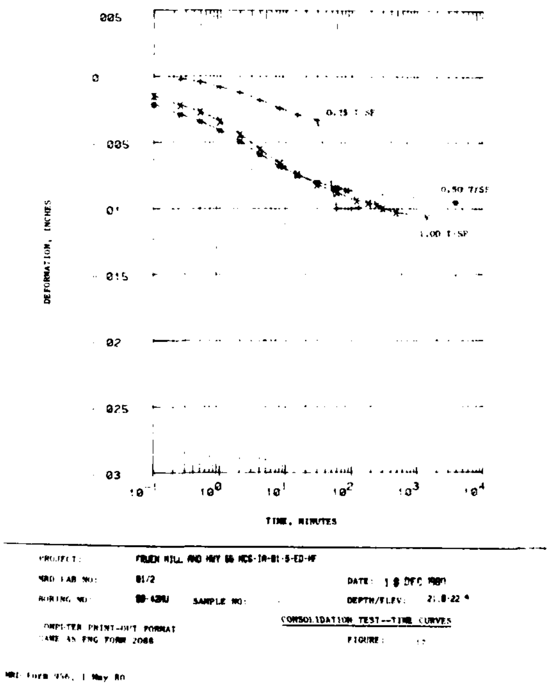


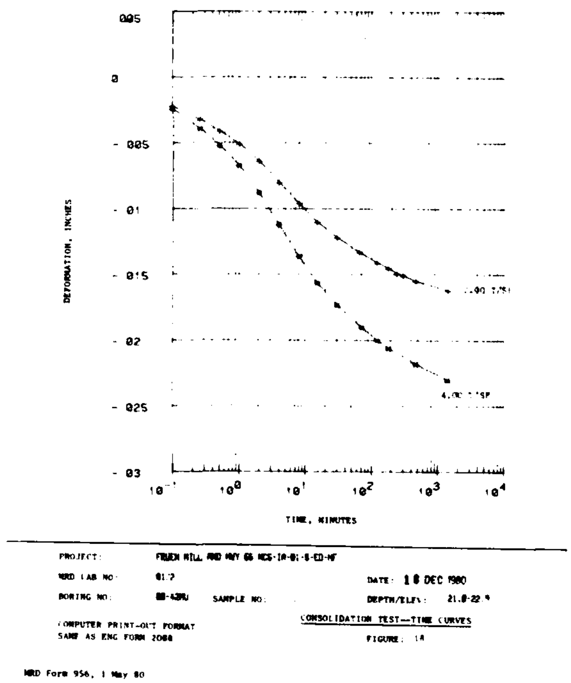












SAFETY PAYS

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

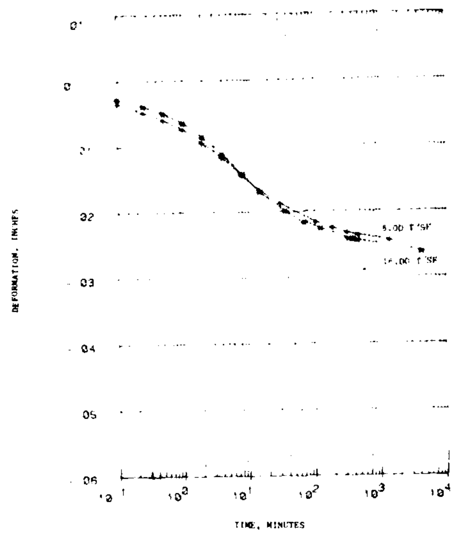
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
HIGHWAY 55 CONTROL STRUCTURE
BORING 80-42MU

DATE: AUGUST 1982

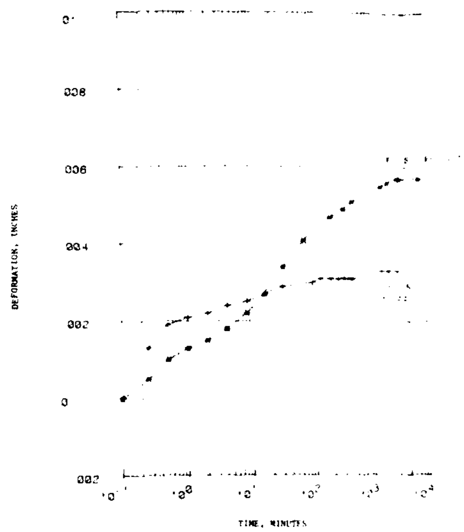
DRAWING NUMBER
M34.3-R-5/250
SHEET C-22 OF C-39

2



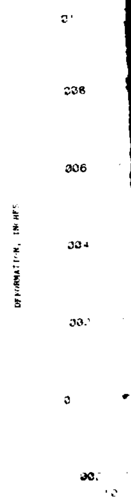
PROJECT: FRUEH HILL AND HWY 66 NCS-IR-81-5-ED-HF
MRD LAB NO: 81-2
BORING NO: 80-420U
SAMPLE NO:
DATE: 18 DEC 1980
DEPTH/ELEV: 21.8-22.4
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST—TIME CURVES
FIGURE:

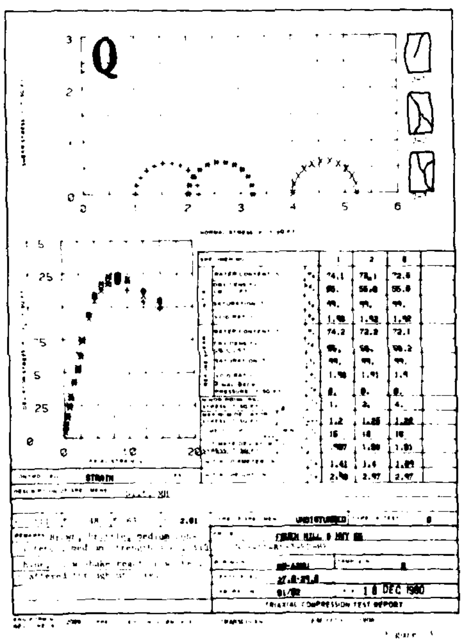
MRD Form 956, 1 May 80

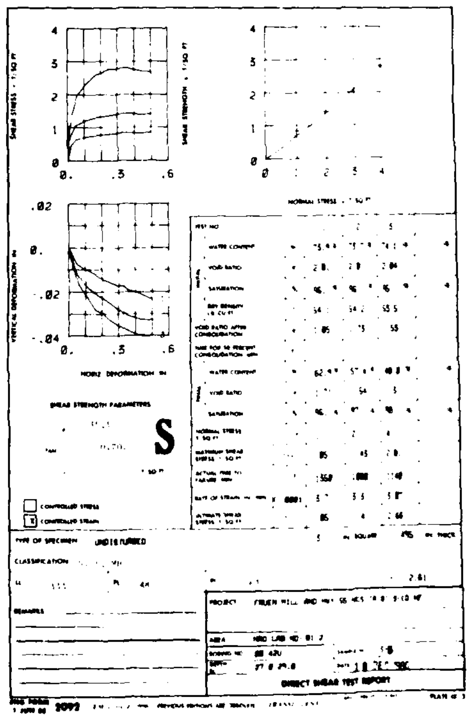


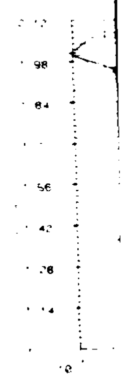
PROJECT: FRUEH HILL AND HWY 66 NCS-IR-81-5-ED-HF
MRD LAB NO: 81-2
BORING NO: 80-420U
SAMPLE NO:
DATE: 18 DEC 1980
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
CONSOLIDATION TEST—TIME CURVES
FIGURE

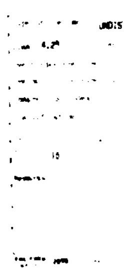
MRD Form 956, 1 May 80

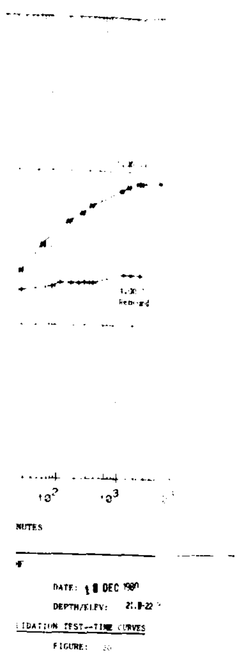


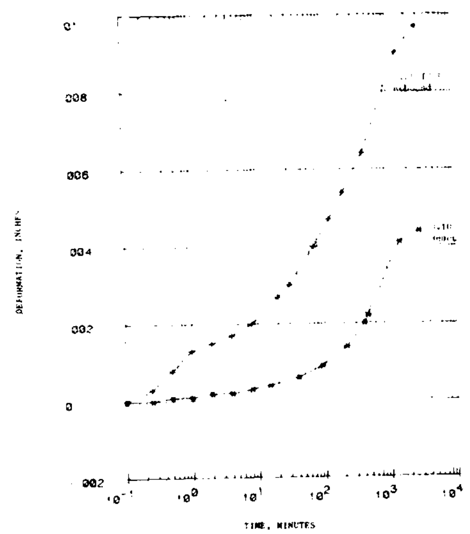






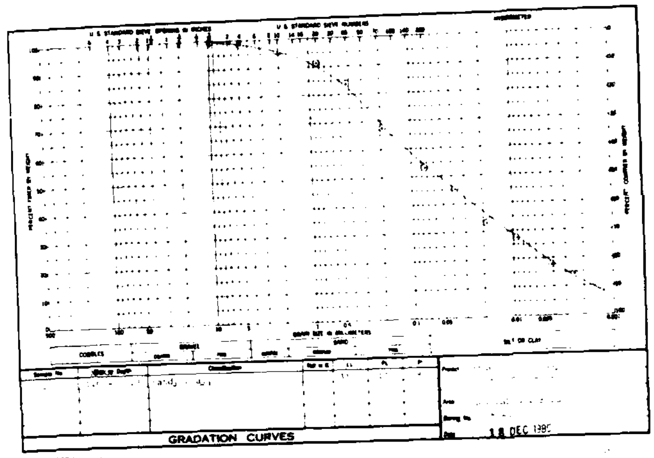




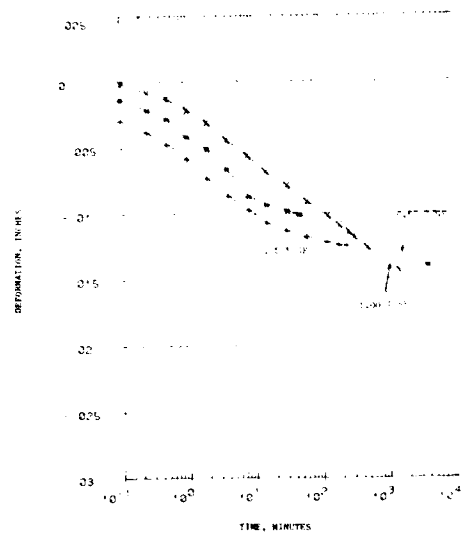


PROJECT: FRUEN MILL AND HWY 55 NCS-IR-81-5-ED-HF
MRD LAB NO: 81/2
DATE: 1 8 DEC 1980
BORING NO: 80-42MU SAMPLE NO:
DEPTH/ELEV: 21.8-22.9
CONSOLIDATION TEST--TIME CURVES
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
FIGURE: 1

MRD Form 956, 1 May 80

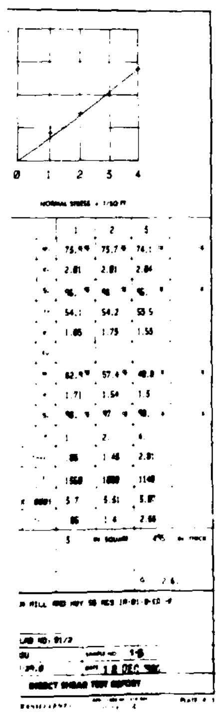


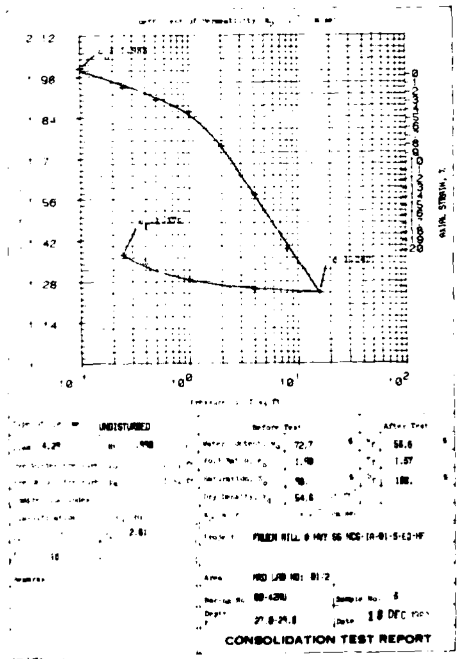
ENG FORM 2087



PROJECT: FRUEN MILL & HWY 55 NCS-IR-81-5-ED-HF
MRD LAB NO: 81 2
DATE: 1 8 DEC 1980
BORING NO: 80-42MU SAMPLE NO: 5
DEPTH/ELEV: 27.8-29.8
CONSOLIDATION TEST--TIME CURVES
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088
FIGURE:

MRD Form 956, 1 May 80





DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

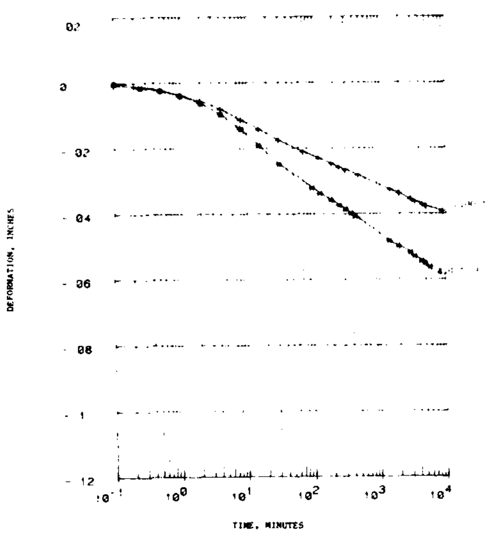
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
HIGHWAY 55 CONTROL STRUCTURE
BORING 80-42MU

SUBMITTED BY:
APPROVED:

DATE: AUGUST 1982

DRAWING NUMBER M34.3-R-5/251
SHEET C-23 OF C-39

2.



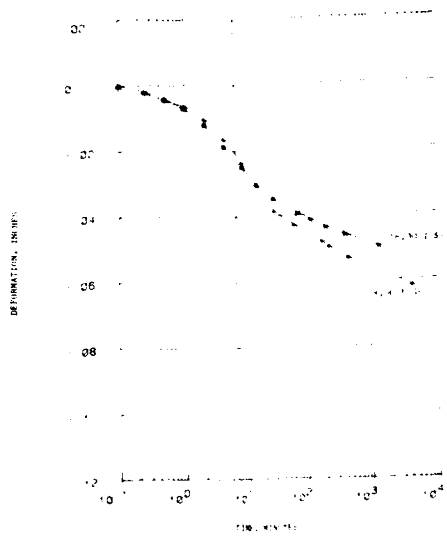
PROJECT: FRUEN MILL @ HWY 66 NCS-IA-01-S-ED-HF
MRD LAB NO: 81/2 DATE: 18 DEC 1980
BORING NO: 80-42MU SAMPLE NO: 3 DEPTH/ELEV: 27.0-29.0

CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: [illegible]

MRD Form 956, 1 May 80



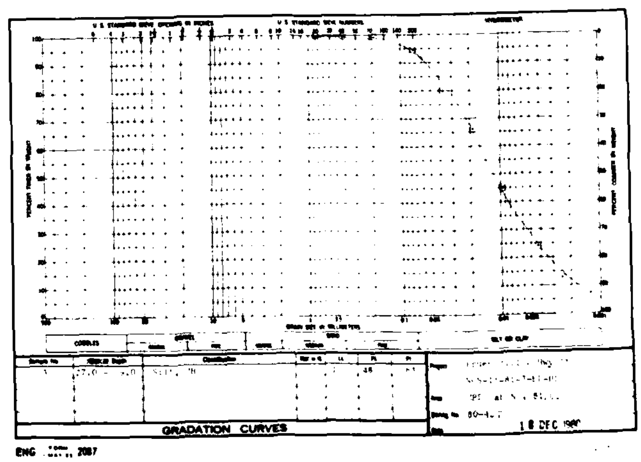
PROJECT: FRUEN MILL @ HWY 55 NCS-IA-01-S-ED-HF
MRD LAB NO: 81/2 DATE: 18 DEC [illegible]
BORING NO. 80-42MU SAMPLE NO. 3 DEPTH/ELEV: 27.0-29.0

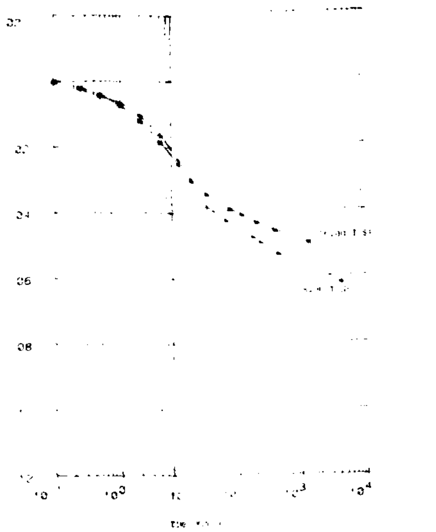
CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE [illegible]

MRD Form 956, 1 May 80

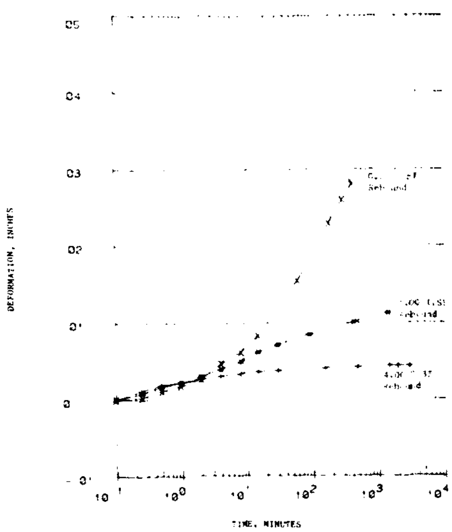




FRUEN MILL @ HWY 55 NCS-IR-81-...

81/2 — 18 DEC ...

80-42MU SAMPLE NO: 6 — 27.8-29.8



PROJECT: FRUEN MILL @ HWY 55 NCS-IR-81-5-CO-HF

MRD LAB NO: 81/2 DATE: 18 DEC 1981

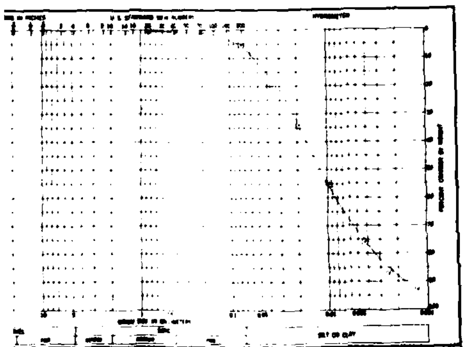
BORING NO: 80-42MU SAMPLE NO: 3 DEPTH/ELEV: 27.8-29.8

CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE:

MRD Form 956, 1 May 80



DATION CURVES

Fruen Mill @ Hwy 55

MRD Lab No. 81/02

80-42MU

18 DEC 19

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA

HIGHWAY 55 CONTROL STRUCTURE

BORING 80-42MU

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

DATE: AUGUST 1982

SCALE:

DRAWING NUMBER
M34.3-R-5/252
SHEET C-24 OF C-39

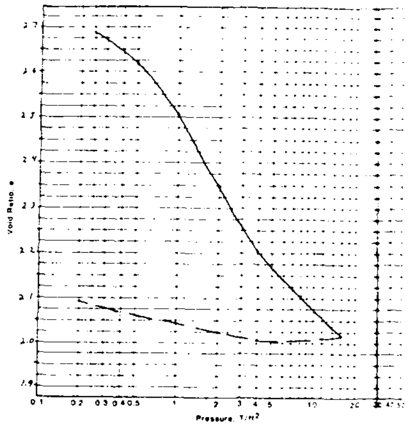
BC-4A, Organic Muck (19½-21½)

Original Moisture Content -- [illegible]
Original Dry Density -- 42.7 lb/ft^3
Plastic Index -- [illegible]
Specific Gravity -- 2.56
C_c -- 2.56

Loading	Void Ratio - e	Permeability - K	C_v
.25 TSF	2.686		2.35×10^{-2}
.5 TSF	2.620		8.70×10^{-3}
1 TSF	2.502		2.40×10^{-3}
2 TSF	2.349		2.26×10^{-3}
4 TSF	2.259		1.50×10^{-3}
8 TSF	2.105		1.62×10^{-3}
16 TSF	2.017		2.46×10^{-3}
4 TSF (unloading)	2.004		
1 TSF (unloading)	2.044		
.25 TSF (unloading)	2.088		

CONSOLIDATION TEST

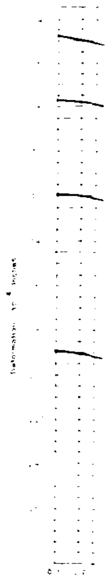
VOID RATIO VS. PRESSURE



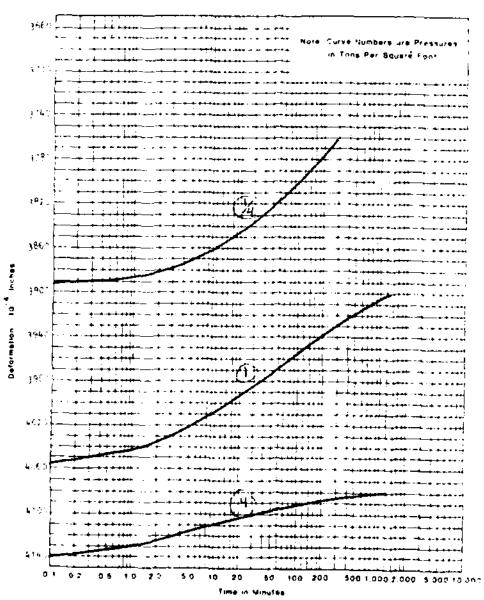
Project: Bassett Creek
Job No.: 23/27-144 ECB 04
Boring No.: BC-4A
Sample No.:
Depth: 19½-21½
Initial Sample Height: .75"
Sample Diameter: 2.5"
Description of Sample: Organic Muck

Date: 4/8/80
Tested by: MAR + JAS
Original Moisture Content: 923%
Original Dry Density: 42.7 #/cu ft
Liquid Limit: 138.0%
Plastic Limit: 65.6%
Overburden Pressure, Po:
Preconsol. Pressure, Pc:
Compression Index, Cc: 4.5

BARR ENGINEERING CO.

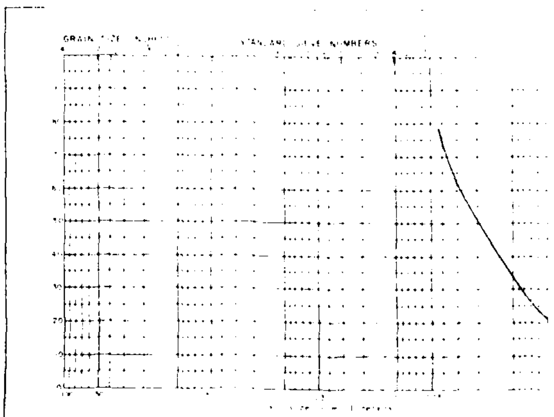


CONSOLIDATION TEST - TIME CURVES



Project: BASSETT CREEK | Job No.:
Sample No.: Organic Muck | Boring No.: BC-4A | Depth: 19½-21½

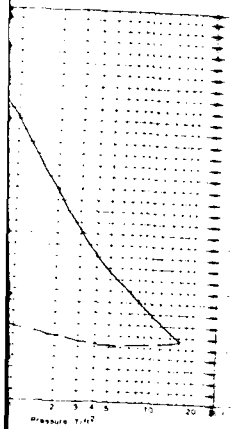
BARR ENGINEERING CO.



GRAIN SIZE DISTRIBUTION DIAGRAM

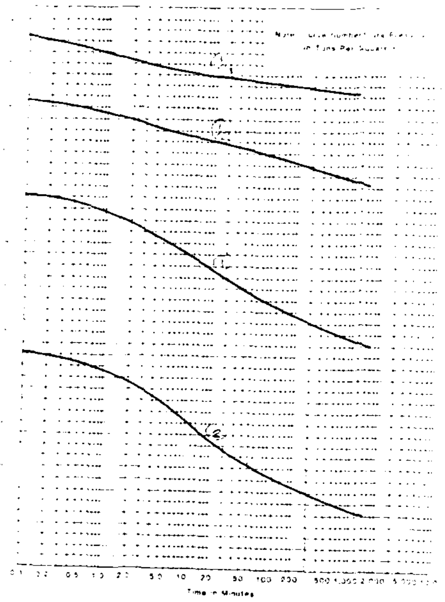
Project: BASSETT CREEK | Job No.:
Sample: Organic Muck | Boring No.: BC-4A | Depth: 19½-21½

ONSOLIDATION TEST
OID RATIO VS PRESSURE



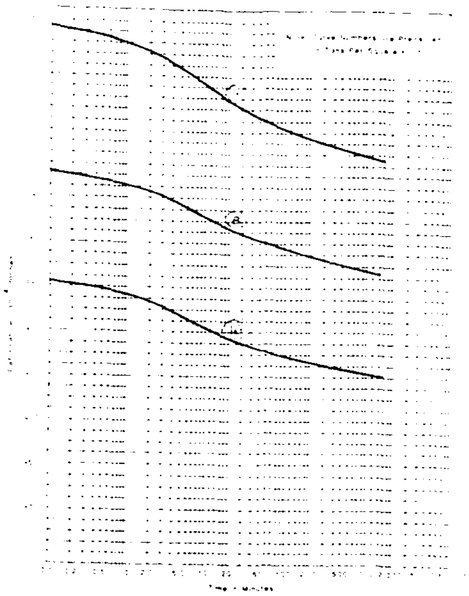
Date 4/8/80
Tested by MBR
Original Moisture Content
Original Dry Density 42.7
Liquid Limit 138
Plastic Limit 65
Overburden Pressure Po
Preconsol. Pressure Pc
Compression Index Cc

CONSOLIDATION TEST - TIME CURVES

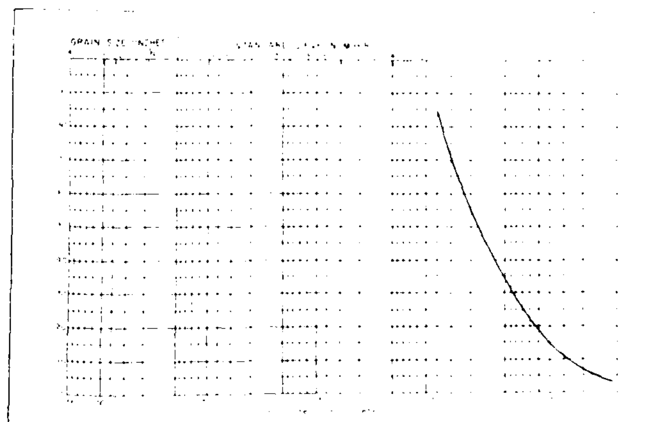


BARR ENGINEERING CO.

CONSOLIDATION TEST - TIME CURVES

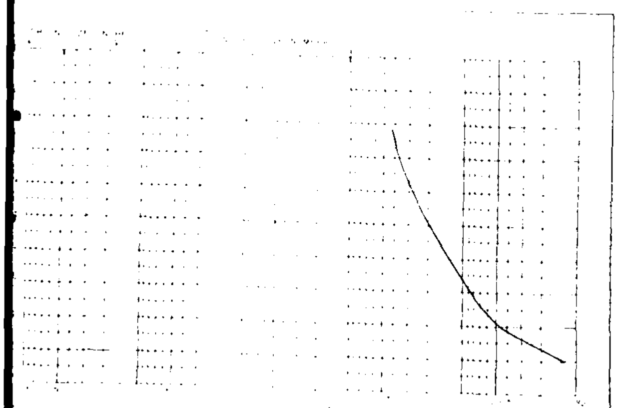


BARR ENGINEERING CO.



GRAIN SIZE DISTRIBUTION DIAGRAM

Project BASSETT CREEK



GRAIN SIZE DISTRIBUTION DIAGRAM

Project BASSETT CREEK

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL MINNESOTA

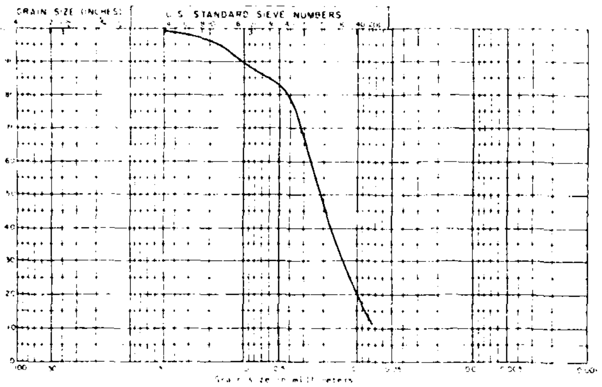
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
APPROVED

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
HIGHWAY 100 EMBANKMENT
BORING BC-4A

DATE
AUGUST 1982

DRAWING NUMBER
M34.3-R-5/253
SHEET C-25 OF C-39

2



GRAIN SIZE DISTRIBUTION DIAGRAM

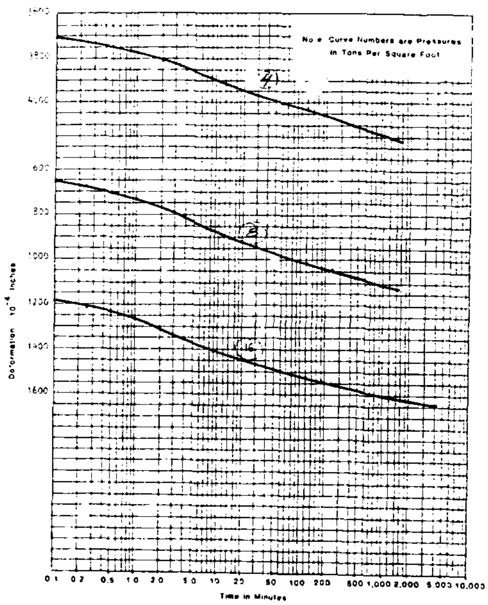
Project Bassett Creek Job No.

Sample No. 9 Boring No. BC 4A Depth 29½'-31'

BARR ENGINEERING CO.
Minneapolis, Minnesota

Loading		
.25 TSF	[illegible]	[illegible]
1 TSF		[illegible]
2 TSF	[illegible]	[illegible]
4 TSF	[illegible]	[illegible]
8 TSF	[illegible]	[illegible]
16 TSF	[illegible]	[illegible]
4 TSF (unloading)	[illegible]	
1 TSF (unloading)	[illegible]	
.25 TSF (unloading)	[illegible]	

CONSOLIDATION TEST - TIME CURVES

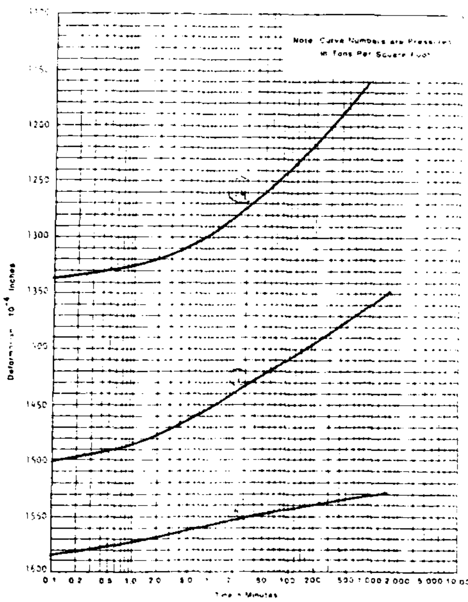


Project Bassett Creek Job No.

Sample No. Boring No. BC 4C Depth

BARR ENGINEERING CO.
CONSULTING ENGINEERS

CONSOLIDATION TEST - TIME CURVES



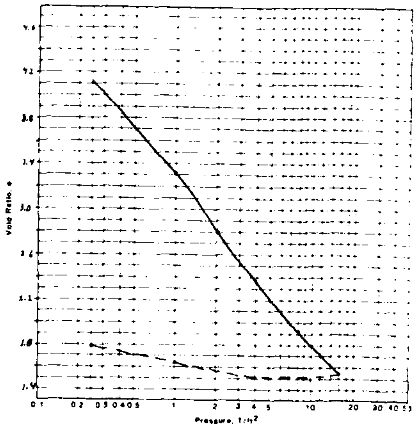
Project Bassett Creek Job No.

Sample No. Boring No. Depth

BARR ENGINEERING CO.
CONSULTING ENGINEERS

CONSOLIDATION TEST

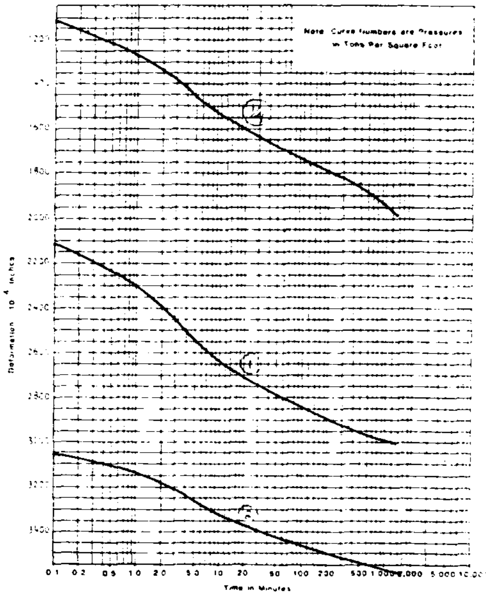
VOID RATIO VS PRESSURE



Project Bassett Creek	Date 2/29/80
Job No 23/27-144 ECB 04	Tested by MAR + DAS
Boring No BC-4C	Original Moisture Content 191.0 %
Sample No Thinwall	Original Dry Density 26 lb/ft³
Depth 14½-16½	Liquid Limit 153.0 %
Initial Sample Height .75"	Plastic Limit 96.7 %
Sample Diameter 2.5"	Overburden Pressure, Po
Description of Sample Muck	Preconsol. Pressure Pc
	Compression Index, Cc 1.5

BARR ENGINEERING CO
CONSULTING ENGINEERS

CONSOLIDATION TEST - TIME CURVES

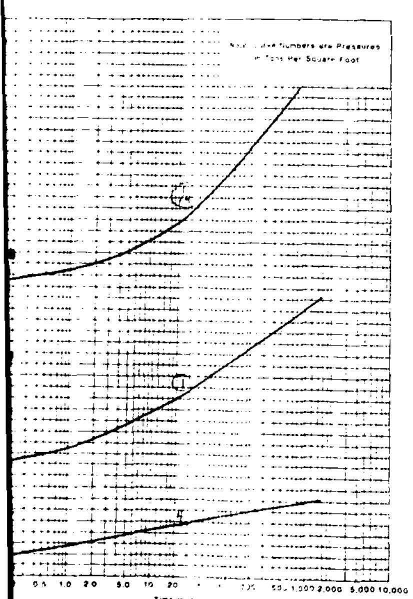


Project Bassett Creek Job No

Sample No Muck Boring No BC-4C Depth 14½-16½

BARR ENGINEERING CO
CONSULTING ENGINEERS

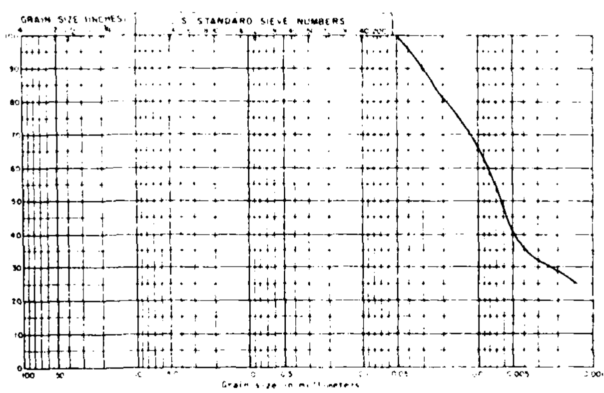
CONSOLIDATION TEST - TIME CURVES



Bassett Creek Job No

Boring No Depth

BARR ENGINEERING CO
CONSULTING ENGINEERS



GRAIN SIZE DISTRIBUTION DIAGRAM

Project BASSETT CREEK Job No

Sample No Muck Boring No BC4C Depth 14½-16½

BARR ENGINEERING CO
Minneapolis, Minnesota

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA

HIGHWAY 100 EMBANKMENT

BORINGS BC-4A & BC-4C

DATE: AUGUST 1982

SCALE SPEC. No

DRAWING NUMBER
M34.3-R-5/254

SHEET C-26 OF C-39

2

BL-4D Organic Silt, 24'-26'

Original Moisture Content -- [illegible]

Original Dry Density -- [illegible]

Plastic Index -- Non Plastic

C_c -- .037

Specific Gravity -- 2.70

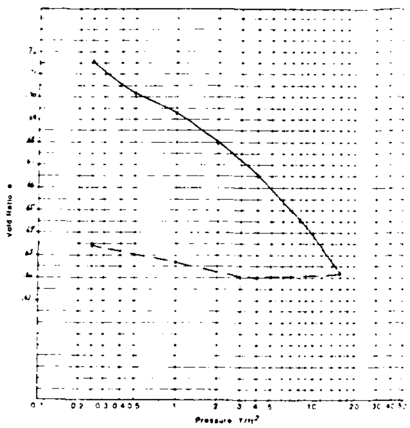
Ash Content -- [illegible]

Organic Content -- [illegible]

Loading	Void Ratio, e	Permeability (K)	C_v
.25 TSF	.71[illegible]	[illegible]68 x 10^{-6}	[illegible] x [illegible]$^{-1}$
.5 TSF	.702		2.31 x 10^{-1}
1 TSF	.693		2.26 x [illegible]
2 TSF	.68[illegible]		2.25 x [illegible]$^{-1}$
4 TSF	.665	6.6[illegible] x [illegible]$^{-6}$	2.21 x 10^{-1}
8 TSF	.646		2.16 x [illegible]$^{-1}$
16 TSF	.622		2.16 x 10^{-1}
4 TSF (unloading)	.62[illegible]		
1 TSF (unloading)	.62[illegible]		
.25 TSF (unloading)	.63[illegible]		

CONSOLIDATION TEST

VOID RATIO VS PRESSURE



Project: Bassett Creek

Job No: [illegible] ECB 04

Boring No: BL-4D

Sample No: Thomwall

Depth: 24'-26'

Initial Sample Height: .75"

Sample Diameter: 2.5"

Description of Sample: Organic Silt

Date: 3/4/82

Tested by: MAR & DAL

Original Moisture Content: 26.6%

Original Dry Density: 95.2 #/ft³

Liquid Limit: 26.5%

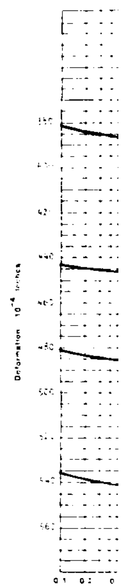
Plastic Limit: 27.8%

Overburden Pressure Po:

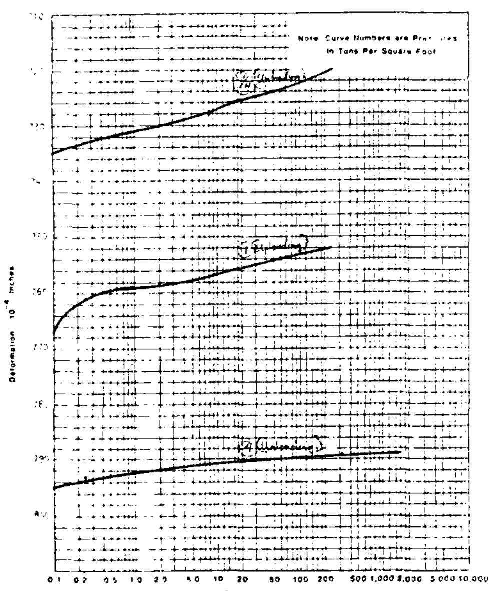
Preconsol. Pressure Pc:

Compression Index Cc: .037

BARR ENGINEERING CO.



CONSOLIDATION TEST - TIME CURVES



Project: Bassett Creek

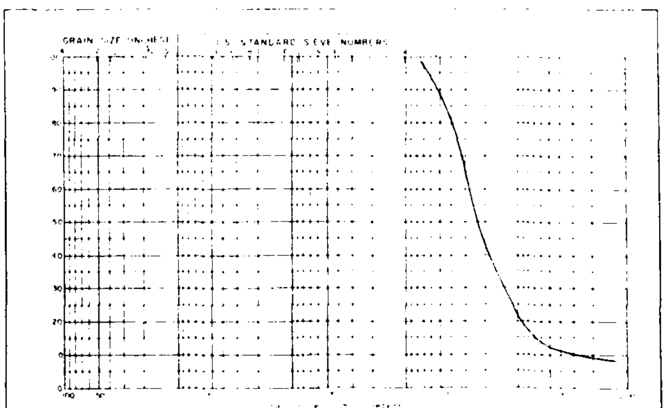
Job No:

Sample No: Organic Silt

Boring No: BL-4D

Depth: 24'-26'

BARR ENGINEERING CO.
CONSULTING ENGINEERS



GRAIN SIZE DISTRIBUTION DIAGRAM

Project: BASSETT CREEK

Job No:

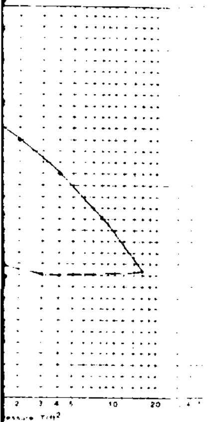
Sample No: [illegible]

Boring No: BL-4D

Depth: [illegible]

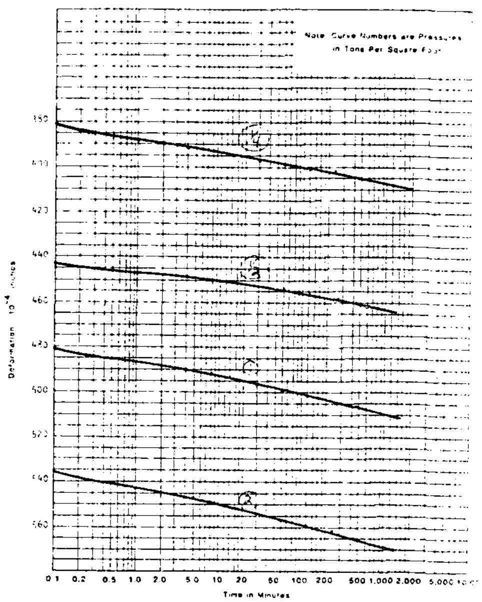
BARR ENGINEERING CO.

DATION TEST
IO VS PRESSURE



Date 3/4/80
Tested by MAR & ...
Original Moisture Content 37...%
Original Dry Density 95.2 ...
Liquid Limit 26.5 %
Plastic Limit 2... 8 %
Overburden Pressure, Po
Preconsol. Pressure, Pc
Compression Index, Cc .037

CONSOLIDATION TEST - TIME CURVES

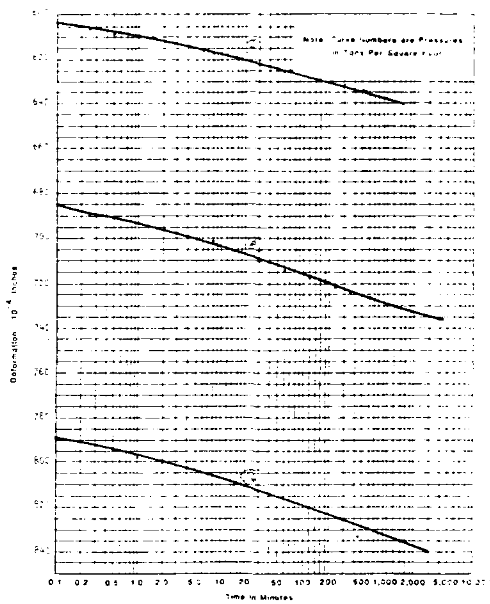


Project: Bassett Creek   Job No.
Sample No.: Organic Silt   Boring No.: BC-40   Depth: 24 - 27'

22

BARR ENGINEERING CO.
CONSULTING ENGINEERS

CONSOLIDATION TEST - TIME CURVES

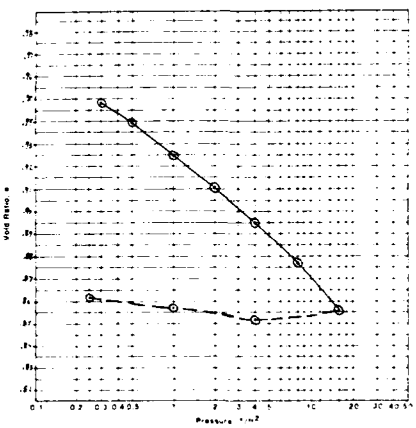


Project: Bassett Creek   Job No.
Sample No.:   Boring No.: BC-41   Depth:

23

BARR ENGINEERING CO.
CONSULTING ENGINEERS

CONSOLIDATION TEST
VOID RATIO VS PRESSURE



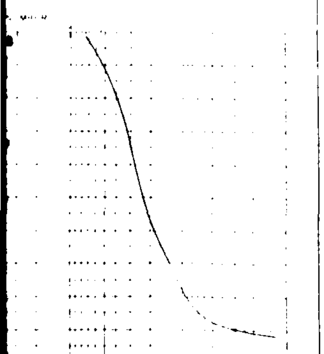
Project: Bassett Creek
Job No.: 23/27-124 ...
Boring No.: BC-41
Sample No.: Dunwell
Depth: 17-19.5'
Initial Sample Height: .75"
Sample Diameter: 2.5"
Description of Sample: Silty-Muck

Date: 3/27/80
Tested by: MAE & CAS
Original Moisture Content: 32.9%
Original Dry Density: 84.39 lb/ft³
Liquid Limit: 56 %
Plastic Limit: 33 %
Overburden Pressure, Po
Preconsol. Pressure, Pc
Compression Index, Cc: .054

BARR ENGINEERING CO.
CONSULTING ENGINEERS

Original Moisture Content
Original Dry Density
Plastic Index -- 24%
Cc -- .036
Specific Gravity -- 2.64
Ash Content
Organic Matter -- 2 %

Loading	Void Ratio, e	Permeability, K	C_v
.25 TSF	.948		[illegible] x 10^{-3}
.5 TSF	.939		9.95 x 10^{-3}
1 TSF	.935		[illegible]
2 TSF	.911		[illegible]
4 TSF	.895		[illegible]
8 TSF	.87[illegible]		5.09 x [illegible]
16 TSF	.856		[illegible].84 x [illegible]
4 TSF (unloading)	.857		
1 TSF (unloading)	.85[illegible]		
2 TSF (unloading)	.862		



BUTION DIAGRAM

Job No.
Depth 49½

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

PHASE II   DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
HIGHWAY 100 EMBANKMENT
BORINGS BC-4D & BC-41

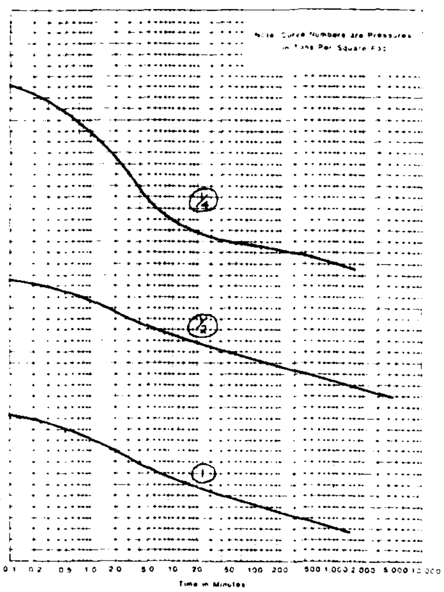
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

DATE: AUGUST 1982

SAFETY PAYS

DRAWING NUMBER
M34.3-R-5/255
SHEET C-27 OF C-39

CONSOLIDATION TEST - TIME CURVES



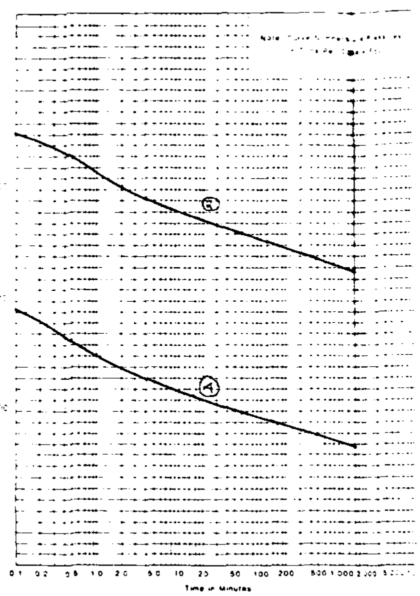
Project Bassett Creek Job No

Sample No Boring No Depth

26

BARR ENGINEERING CO

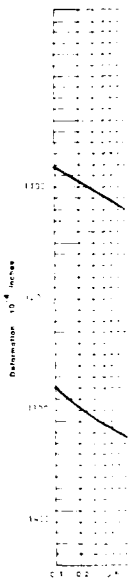
CONSOLIDATION TEST - TIME CURVES

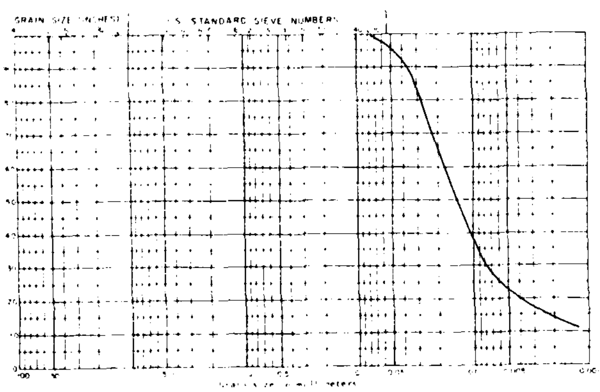


Project Bassett Creek Job No

Sample No Boring No Depth

BARR ENGINEERING CO



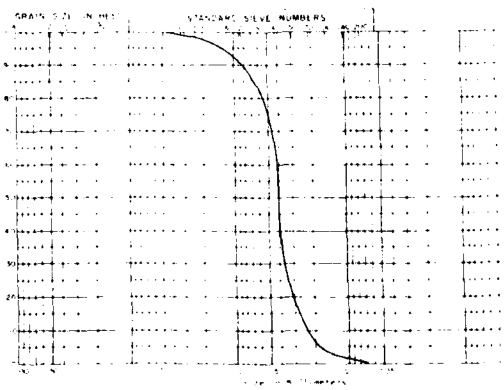


GRAIN SIZE DISTRIBUTION DIAGRAM

Project BASSETT CREEK Job No

Sample No Silt, Muck Boring No BC-4L Depth 17'-19½'

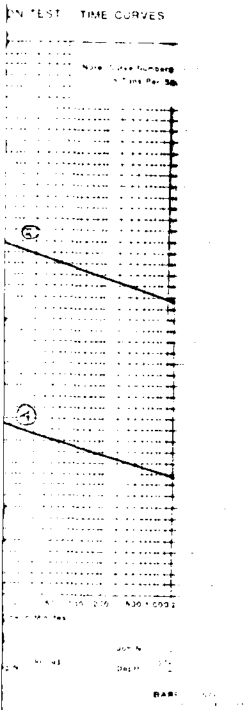
BARR ENGINEERING CO
Minneapolis Minnesota

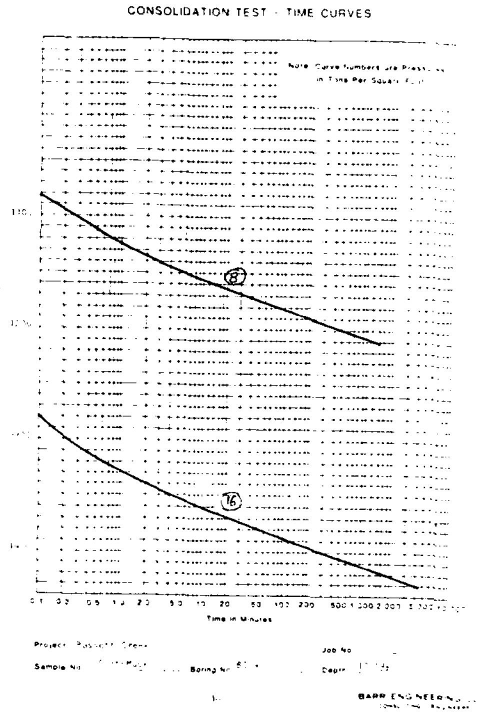


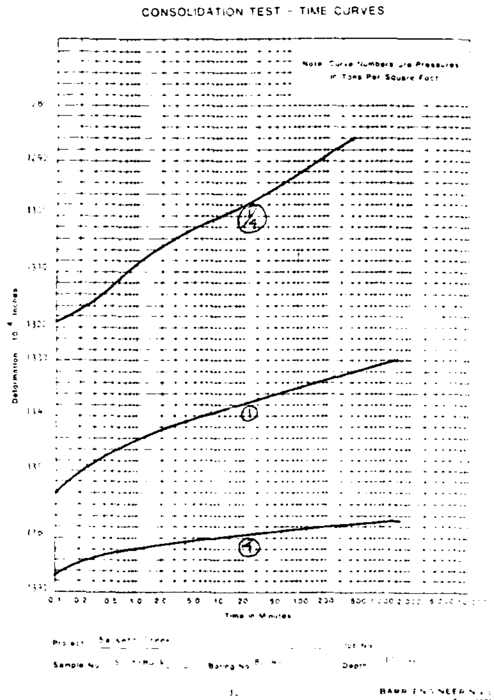
GRAIN SIZE DISTRIBUTION DIAGRAM

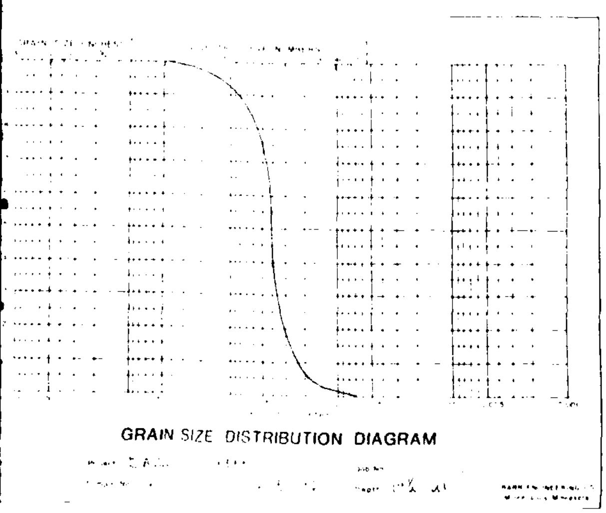
Project Job No

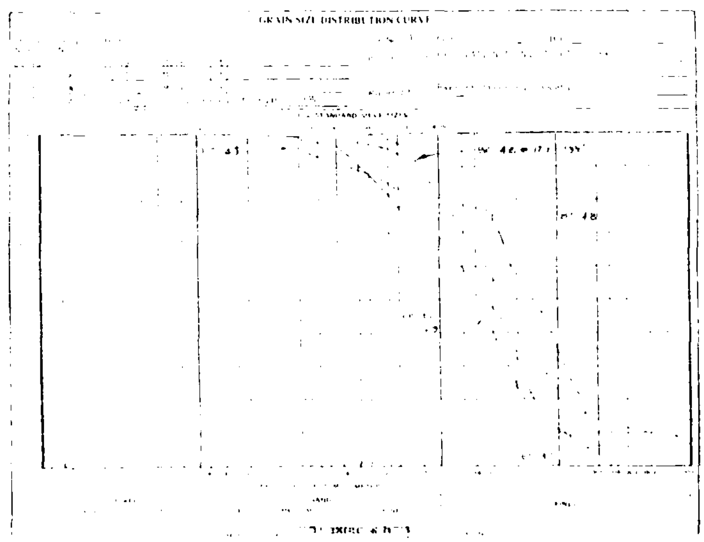
Sample No Boring No Depth











SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA

HIGHWAY 100 EMBANKMENT

BORINGS BC-4I, BC-4C, BC-4J & BC-4Z

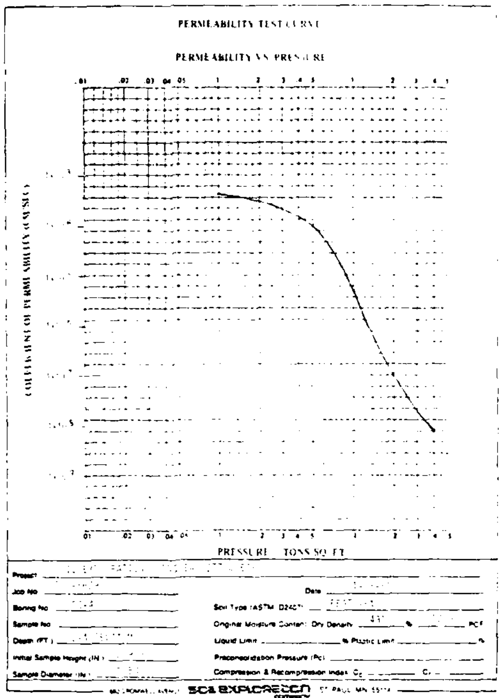
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

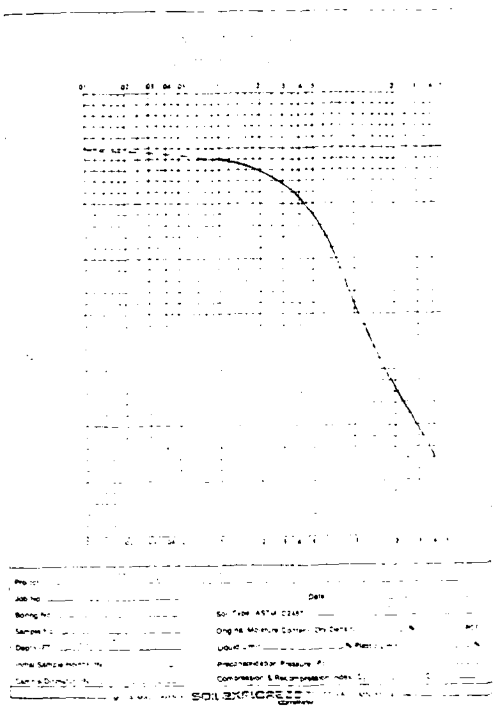
DATE
AUGUST 1982

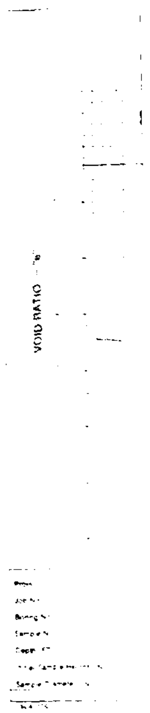
SCALE
SPEC NO

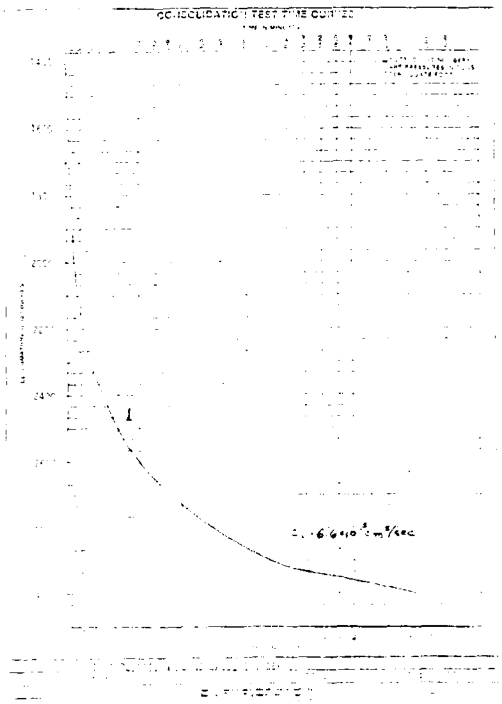
DRAWING NUMBER
M34.3-R-5/256
SHEET C-28 OF C-39

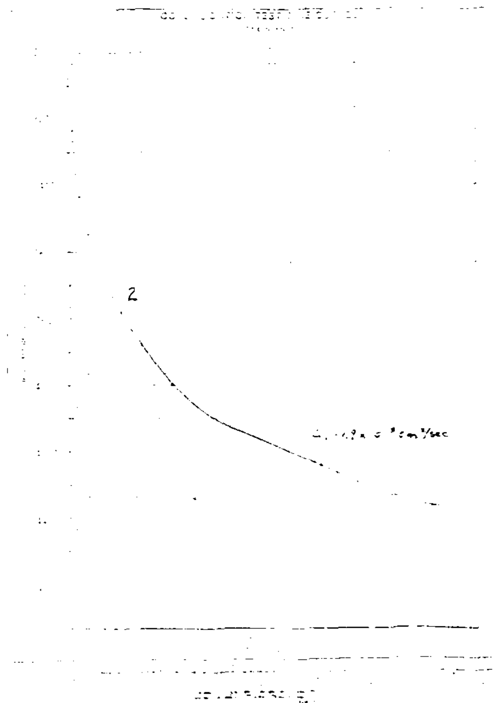
A B C D E


PERMEABILITY TEST CURVE
PERMEABILITY VS PRESSURE
COEFFICIENT OF PERMEABILITY (CM/SEC)
PRESSURE — TONS SQ FT
Project
Job No
Date
Boring No
Soil Type (ASTM D2487)
Sample No
Original Moisture Content Dry Density
%
PCF
Depth (FT)
Liquid Limit
% Plastic Limit
%
Initial Sample Height (IN)
Preconsolidation Pressure (Pc)
Sample Diameter (IN)
Compression & Recompression Index C_c
SOIL EXPLORATION COMPANY
ST PAUL MN

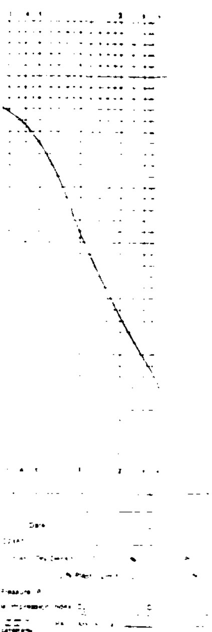

Project
Job No
Date
Boring No
Soil Type ASTM D2487
Sample No
Original Moisture Content Dry Density
Depth (FT)
Liquid Limit
% Plastic Limit
Initial Sample Height (IN)
Preconsolidation Pressure (Pc)
Sample Diameter (IN)
Compression & Recompression Index
SOIL EXPLORATION

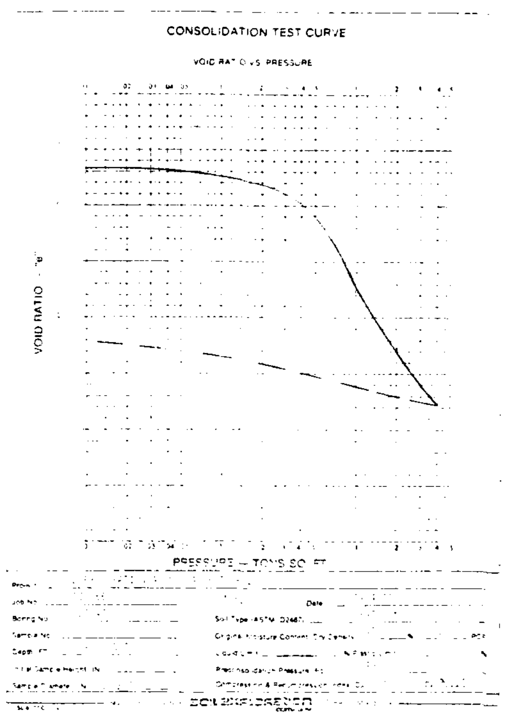

VOID RATIO

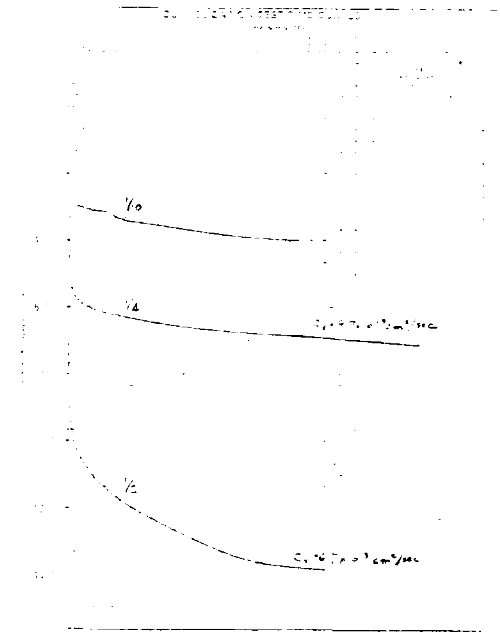

CONSOLIDATION TEST TIME CURVES
1
$C_v = 6.6 \times 10^{-3}$ cm²/sec

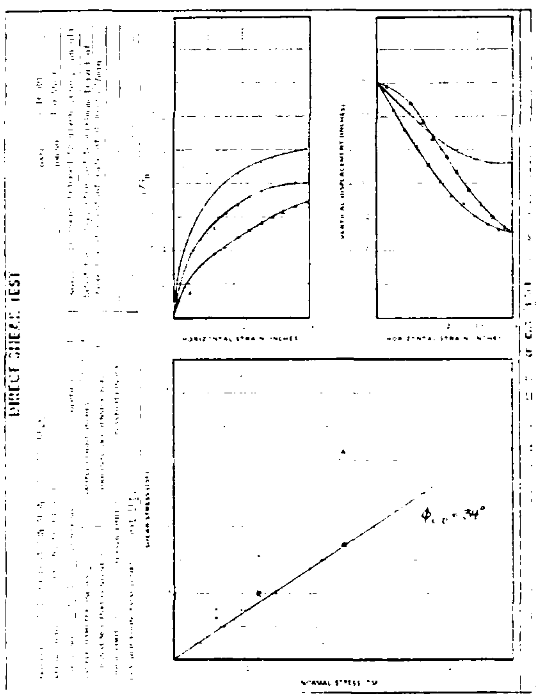

2

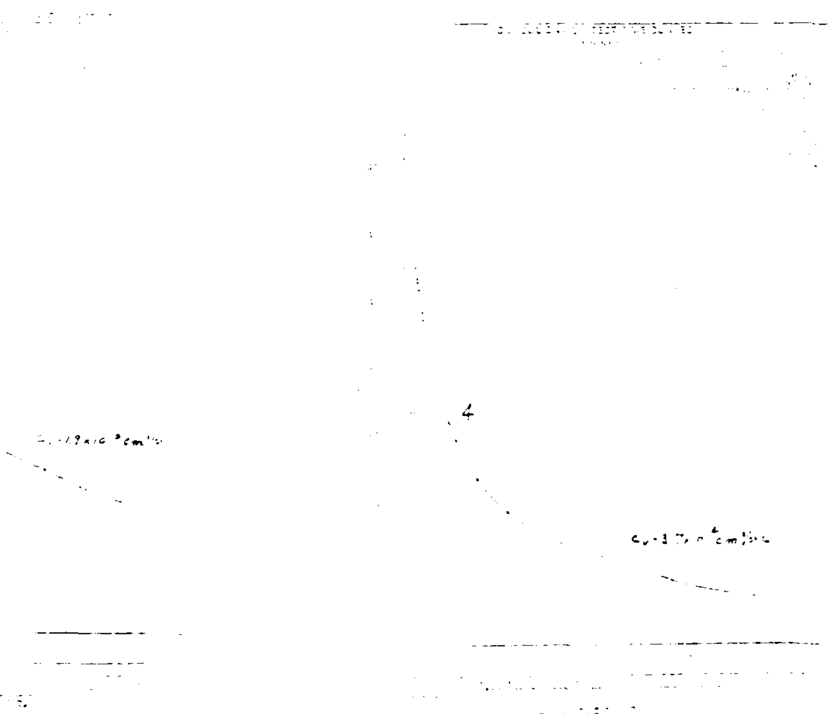
A B C D E











SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
HIGHWAY 100 EMBANKMENT
BORING BC-4C

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

DATE: AUGUST 1982

DRAWING NUMBER
M34.3-R-5/257
SHEET C-29 OF C-39

2

A B C D E F

7

6

5

4

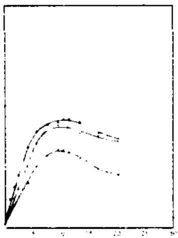
3

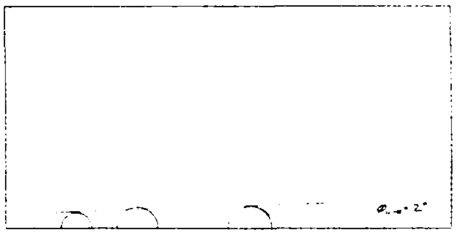
2

1

TRIAXIAL TEST DATA Date Job No

Project
Boring No. Sample No Depth (ft) Type of Sample
Soil Type Type of Test
Remarks

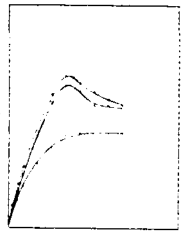


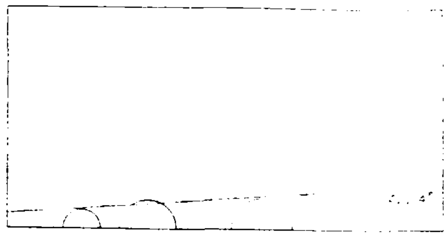


soil exploration company

TRIAXIAL TEST DATA Date Job No

Project
Boring No. Sample No Depth (ft) Type of Sample
Soil Type Type of Test
Remarks

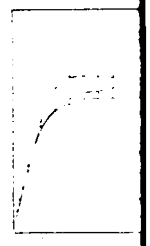


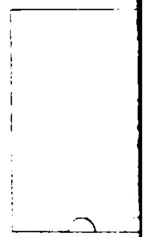


soil exploration company

TRIAXIAL TEST DATA

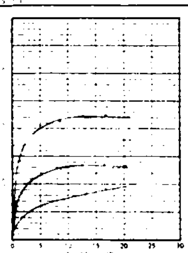
Project
Boring No.
Soil Type
Remarks



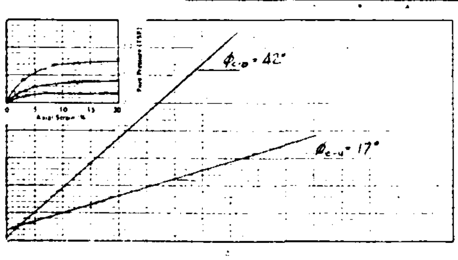


TRIAXIAL TEST DATA Date Job No

Project
Boring No. Sample No Depth (ft) Type of Sample
Soil Type Type of Test
Remarks



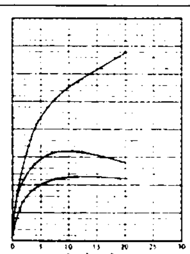
SPECIMEN NO	4		
Initial: Diameter, Inches			
Height, Inches			
Moisture Content, %			
Dry Density, PCF			
Saturation, %			
Void Ratio			
Before Shear: Moisture Content (%)			
Dry Density, PCF			
Saturation (%)			
Void Ratio			
Back Pressure, TSF			
Minor Principal Stress, TSF		1.0	
Maximum Deviator Stress, TSF			
Ultimate Deviator Stress, TSF		[illegible]	
LL	PI		
PL	G_s 2.35		



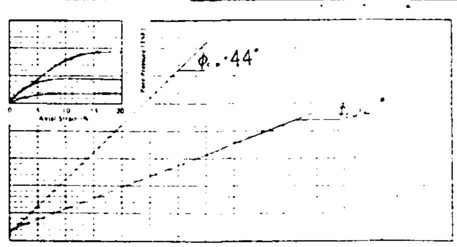
soil exploration company

TRIAXIAL TEST DATA Date Job No

Project
Boring No. Sample No Depth (ft) Type of Sample
Soil Type Type of Test
Remarks



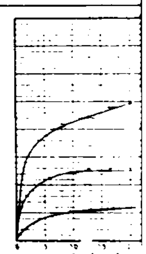
SPECIMEN NO			
Initial: Diameter, Inches			
Height, Inches			
Moisture Content, %			
Dry Density, PCF			
Saturation, %			
Void Ratio			
Before Shear: Moisture Content, %			
Dry Density, PCF			
Saturation, %			
Void Ratio			
Back Pressure, TSF			
Minor Principal Stress, TSF			
Maximum Deviator Stress, TSF			
Ultimate Deviator Stress, TSF			
LL	PI		
PL	G_s		

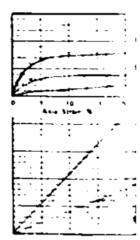


soil exploration company

TRIAXIAL TEST DATA

Project
Boring No. Sample No
Soil Type
Remarks

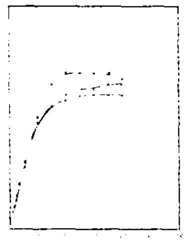


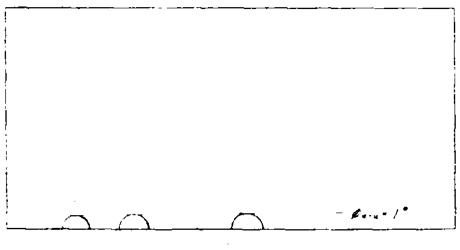


TRIAXIAL TEST DATA

Project: [illegible]

Type of Test: [illegible]





SOIL EXPLORATION COMPANY

TRIAXIAL TEST DATA Date 2-6-80 Job No [illegible]

Project: SOIL EXPLORATION ALONG BASSETT CREEK

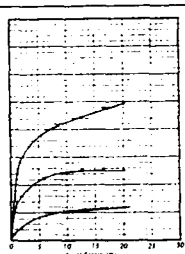
Boring No. BC-4B Sample No. ____ Depth (ft) [illegible] Type of Sample [illegible]

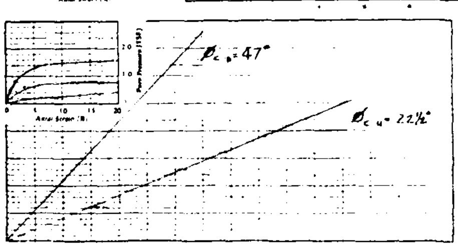
Soil Type [illegible] Type of Test [illegible] with pore pressure

Remarks: Specimens trimmed to sizes shown, drainage strips applied, saturated, consolidated for 1 day, back pressure applied, lines closed, stressed to given strains at constant rate of 0.0024 /min, pore pressure recorded. Maximum stress ratio at [illegible]

SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	[illegible]	[illegible]	
	Height (inches)	[illegible]	[illegible]	
	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)	[illegible]	[illegible]	[illegible]
Minor Principal Stress (TSF)		[illegible]	[illegible]	[illegible]
Maximum Deviator Stress		[illegible]	[illegible]	[illegible]
Ultimate Deviator Stress		≥0.6	≥1.2	—

LL 99.2 PL 43.9 PI 55.9 G_s 2.59





SOIL EXPLORATION COMPANY

TRIAXIAL TEST DATA Date 2-7-80 Job No 120-5629

Project: SOIL EXPLORATION ALONG BASSETT CREEK

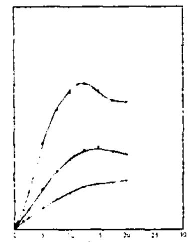
Boring No. BC-4J Sample No. ____ Depth (ft) [illegible] Type of Sample 3" Tel

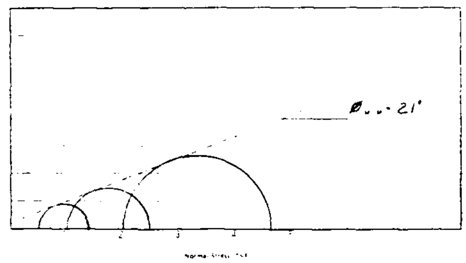
Soil Type: [illegible] Traces of Organic Type of Test: [illegible] UNSATURATED

Remarks: Specimens trimmed to given size, both drainage ends plugged, stressed to given strains at constant rate of 0.063 /min

SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	2.00	2.00	2.00
	Height (inches)	4.00	4.00	4.00
	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
	Back Pressure (TSF)			
Minor Principal Stress (TSF)		[illegible]	[illegible]	[illegible]
Maximum Deviator Stress		0.88	1.48	2.62
Ultimate Deviator Stress		0.8	1.3	[illegible]

LL 23.9 PL 21.8 G_s 2.67





SOIL EXPLORATION COMPANY

TRIAXIAL TEST DATA Date February 29, 1980 Job No 120-5629

Project: SOIL EXPLORATION ALONG BASSETT CREEK

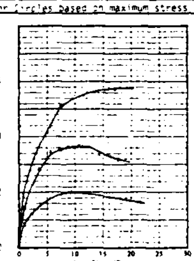
Boring No. BC-4Z Sample No. ____ Depth (ft) 27-29 Type of Sample 3" Tel

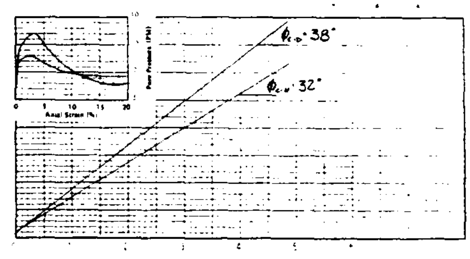
Soil Type: SILT (ML) TRACES OF ORGANIC Type of Test: CU with Pore Pressure

Remarks: Specimens trimmed to given sizes, Drainage strips applied. Saturated and consolidated for total of 3 Days, Back Pressure applied, Drainage lines closed, stressed to given strains at constant rate of 0.0024 /min. Pore Pressures recorded via transducers. Mohr Circles based on maximum stress ratio.

SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	[illegible]	1.39	1.34
	Height (inches)	2.81	2.79	2.64
	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)	≥100	≥100	[illegible]
	Void Ratio			
	Back Pressure (TSF)	1.58	1.58	1.58
Minor Principal Stress (TSF)		0.5	1.0	1.5
Maximum Deviator Stress		2.2	3.6	5.[illegible]
Ultimate Deviator Stress		1.6	3.1	—

LL 22.3 PI 2.1 PL 21.0 G_s 2.67





SOIL EXPLORATION COMPANY

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA
HIGHWAY 100 EMBANKMENT
BORINGS BC-4B, BC-4J, & BC-4Z

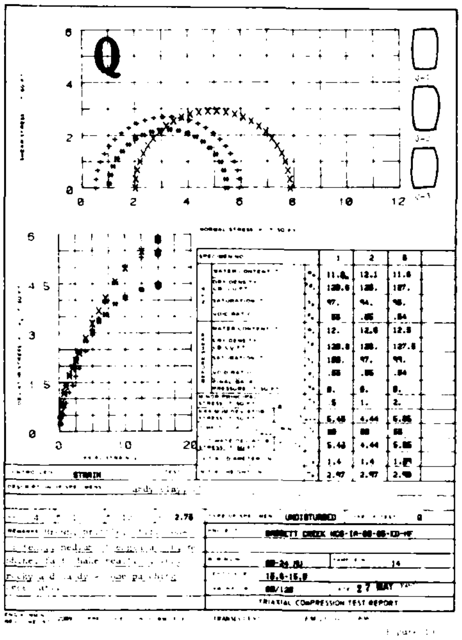
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY: [signature]
APPROVED: [signature]

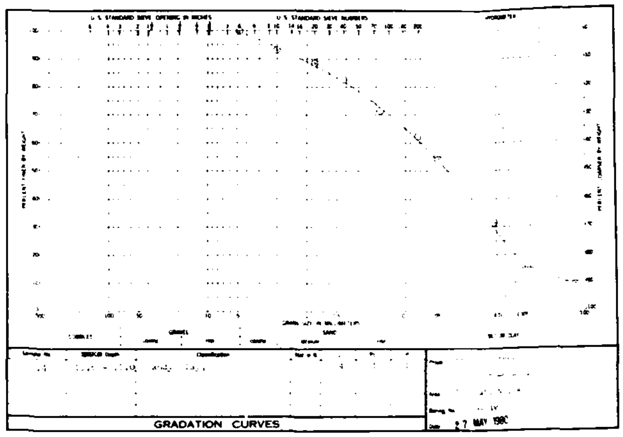
DATE: AUGUST 1982

SAFETY PAYS

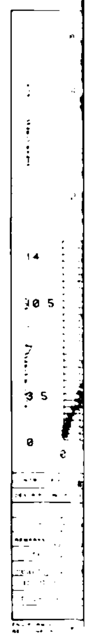
DRAWING NUMBER M34.3-R-5/258
SHEET C-30 OF C-39

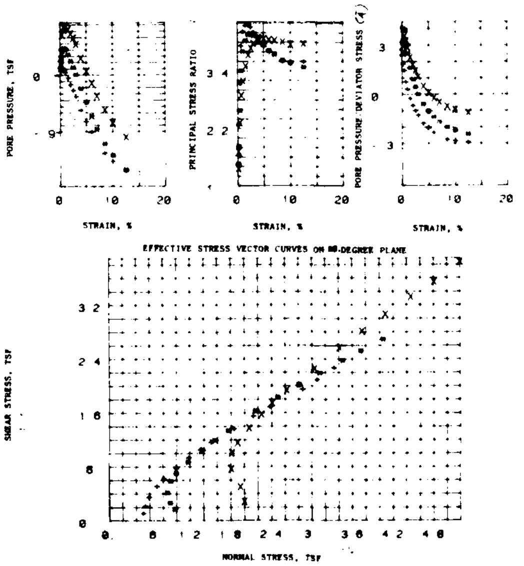
2





ENG 2087





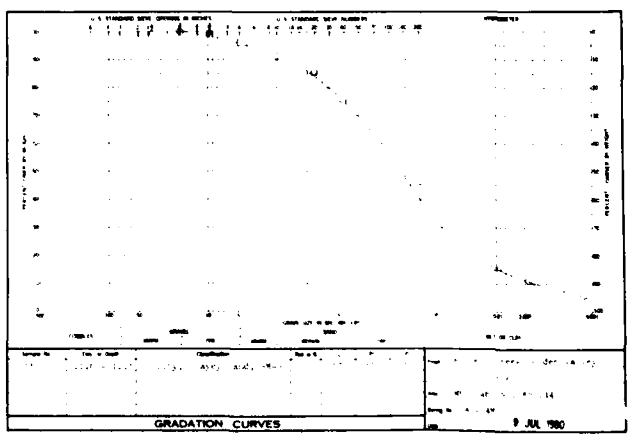
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

NRD Form 756, 1 May 80

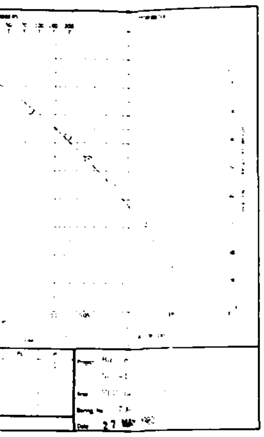
PROJECT:	BRUSHY CREEK GOLDEN VALLEY GOLF COURSE
BORING NO:	80-24M SAMPLE NO: S-15
DEPTH/ELEV:	11.0-12.5
NRD LAB NO:	80/144 DATE: 9 JUL 1980

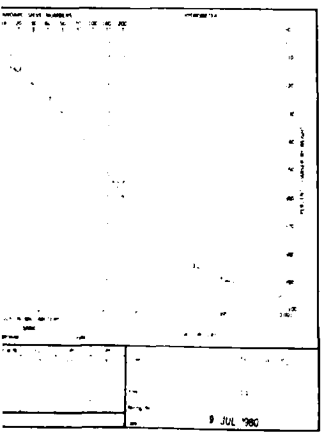
TRIAXIAL COMPRESSION TEST REPORT

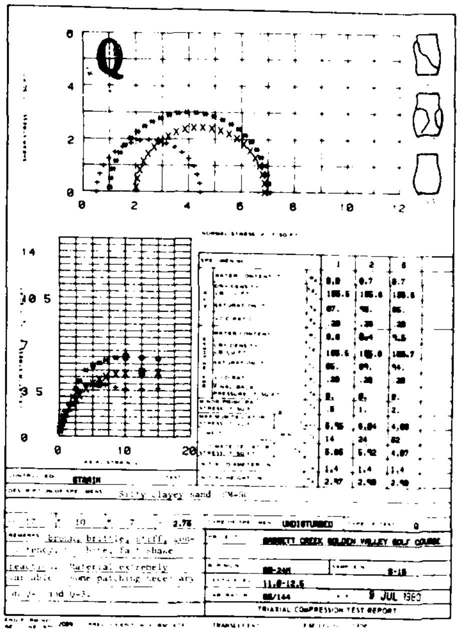
FIGURE: 3

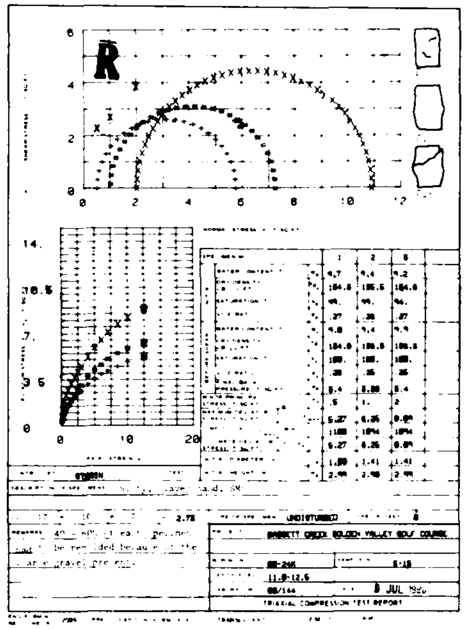


ENG 2087









SOIL CLASSIFICATION RECORD SHEET

Project: Bassett Creek	Boring No: 80-23M, 80-24M, 80-25M	MRD Lab No
Station: - / Range: - / Surf Elev: -	Depth To Water Table: -	Bottom Of Hole: -

Sample No	Depth To Bottom Of Sample	Moisture (%)	LL	PI	.005	[illegible] mm	200	[illegible]	40	20	10	4	3/8	3/4	1 1/2	3	D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech MEMO 3-357, May 67	Remarks
Hole	80-23M																						
1	2.0	11.6	42	25																			
2	4.0	7.1					25	[illegible]	47	65	78	87	[illegible]	100									
3	4.0	17.3					9	[illegible]	32	[illegible]	86	94	100				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
4	[illegible]						17	[illegible]	[illegible]	46	66	87	100										
8	[illegible]						7	[illegible]	13	18	27	42	59	74	100		9.8	[illegible]	[illegible]	44.[illegible]	[illegible]		
10	36.0						54	[illegible]	[illegible]	97	99	100											
Hole	80-24M																						
1	[illegible]						[illegible]		35	45	58	70	81	89	100								
2	6.3						3		5	[illegible]	[illegible]	[illegible]	46	[illegible]	83	100	14.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
3	[illegible]	10.[illegible]	[illegible]	[illegible]																			
6	17.0	7.[illegible]																					
10	[illegible]						[illegible]	[illegible]	88	[illegible]	100						0.[illegible]	0.[illegible]	0.[illegible]	[illegible]	[illegible]		
[illegible]	46.0						No sample recovered																
Hole	80-25M																						
1	[illegible]						6	10		36	50	[illegible]	70	74	100		[illegible]	0.[illegible]	0.1[illegible]	[illegible]	[illegible]		
2	7.0	15.5	[illegible]	[illegible]																			
3	[illegible]	20.9																					
4	[illegible]	18.9					[illegible]	[illegible]	[illegible]	[illegible]	94	[illegible]	98	100									
5	14.5						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	98	100				[illegible]	0.1[illegible]	0.080	[illegible]	[illegible]		
6	17.5	10.0																					
7	[illegible]	9.[illegible]	[illegible]	9																			
10	[illegible]						[illegible]	[illegible]	49	[illegible]	97	[illegible]	100				0.4[illegible]	0.30	[illegible]	[illegible]	[illegible]		

MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE

SYMBOL	DESCRIPTION	DATE	APPROVAL

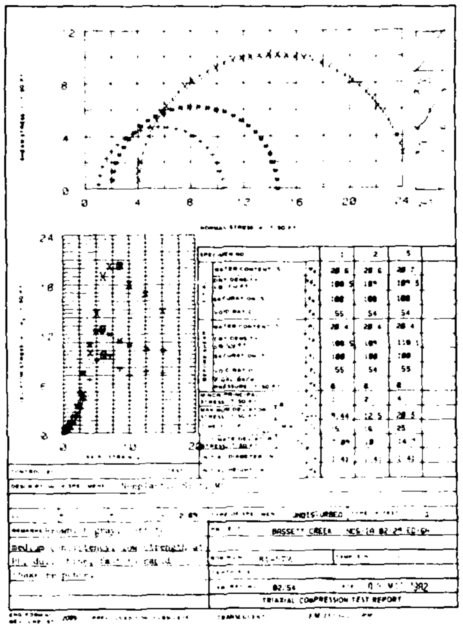
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

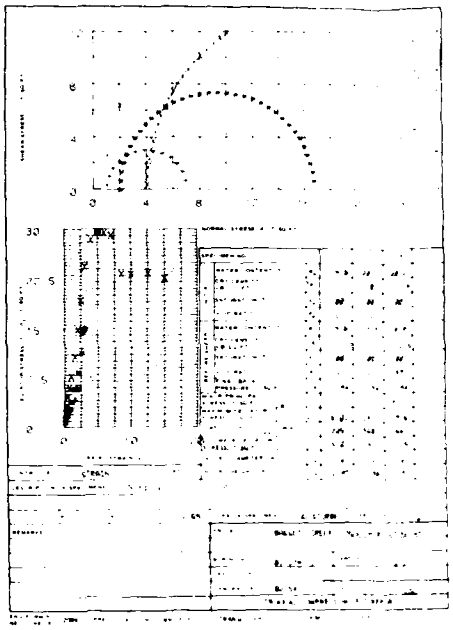
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
GOLDEN VALLEY COUNTRY CLUB EMBANKMENT
BORINGS 80-23M, 80-24M & 80-25M

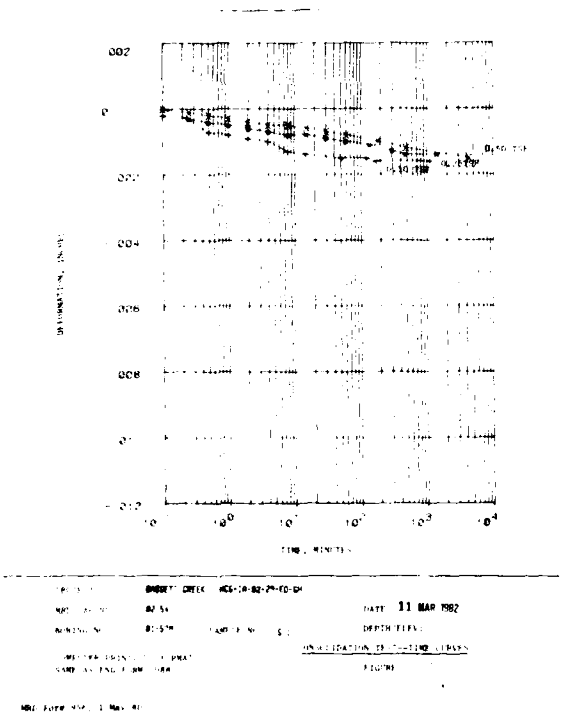
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:
DATE: AUGUST 1982

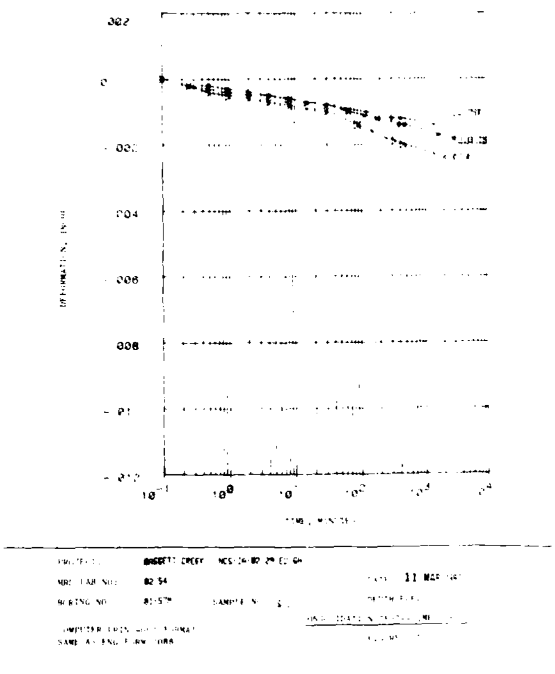
DRAWING NUMBER M34.3-R-5/259
SHEET 0-31 OF C-39

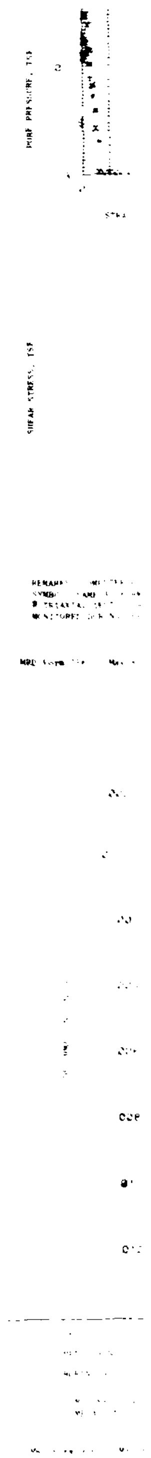
2

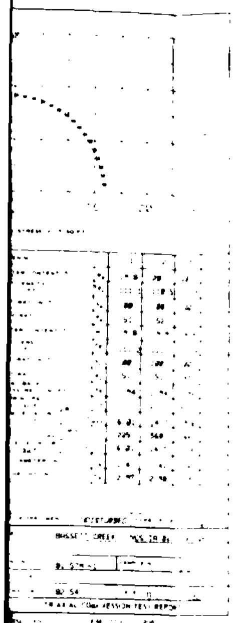

BASSETT CREEK
TRIAXIAL COMPRESSION TEST REPORT

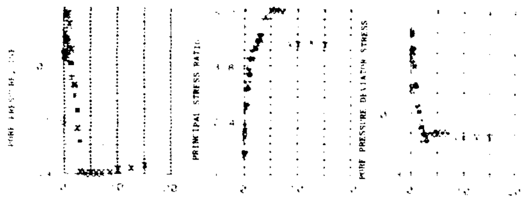


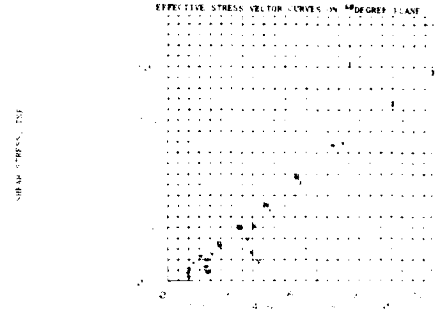

TIME, MINUTES
DATE 11 MAR 1982


TIME, MINUTES
BASSETT CREEK
11 MAR









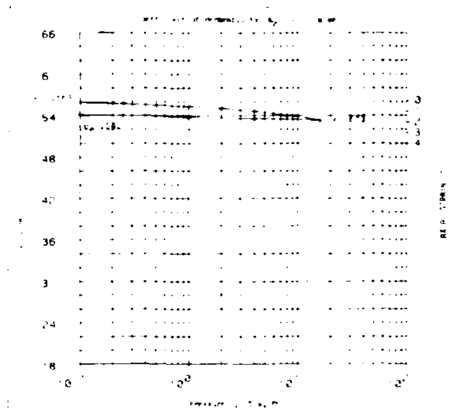
REMARKS: COMPUTER PRINTOUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST, PORE PRESSURE
MONITORED DURING SHEAR

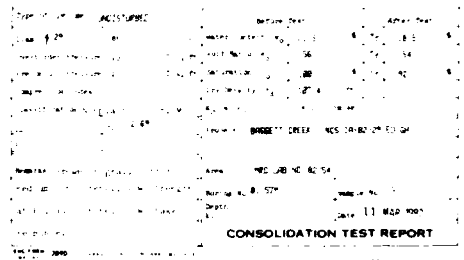
MRD Form 756, 1 May 80

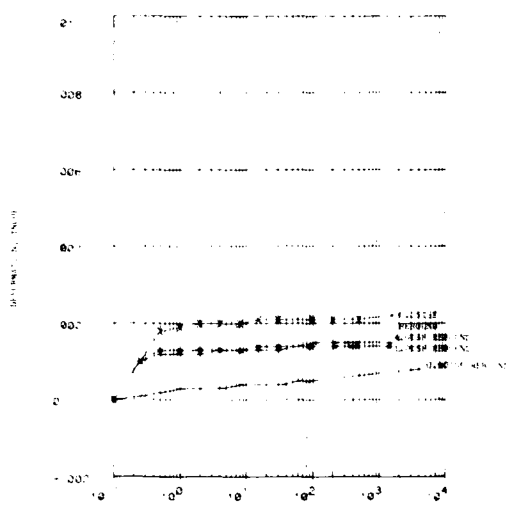
PROJECT: BASSETT CREEK NCS-IR-82-29-ED GH
BORING NO: 81-57M SAMPLE NO:
DEPTH ELEV:
MRD LAB NO: 82 54 DATE: 11 MAR 82

TRIAXIAL COMPRESSION TEST REPORT

FIGURE





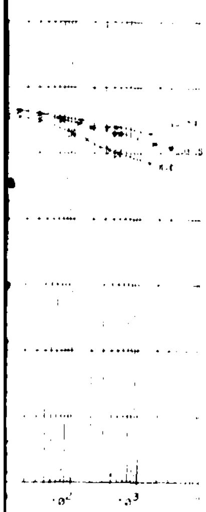


PROJECT: BASSETT CREEK NCS-IR-82-29-ED GH
MRD LAB NO: 82 54 DATE: 11 MAR 1982
BORING NO: 81-57M SAMPLE NO: S-1 DEPTH ELEV:
REMARKS: COMPUTER PRINTOUT FORMAT
SIMILAR TO ENG FORM 2088

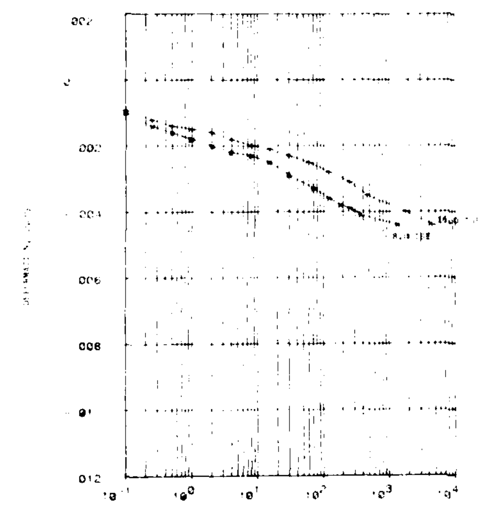
CONSOLIDATION TEST—TIME CURVE

FIGURE

MRD Form 756, 1 May 80



DATE: 11 MAR 1982
DEPTH ELEV:
CONSOLIDATION TEST—TIME CURVE
FIGURE



PROJECT: BASSETT CREEK NCS-IR-82-29-ED GH
MRD LAB NO: 82 54 DATE: 11 MAR 1982
BORING NO: 81-57M SAMPLE NO: S-1 DEPTH ELEV:
REMARKS: COMPUTER PRINTOUT FORMAT
SIMILAR TO ENG FORM 2088

CONSOLIDATION TEST—TIME CURVE

FIGURE 4

MRD Form 756, 1 May 80

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

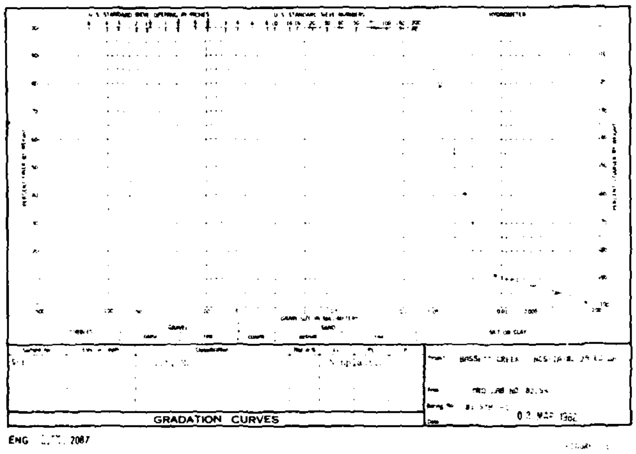
DESIGNED BY
DRAWN BY
CHECKED BY
SUBMITTED BY
APPROVED

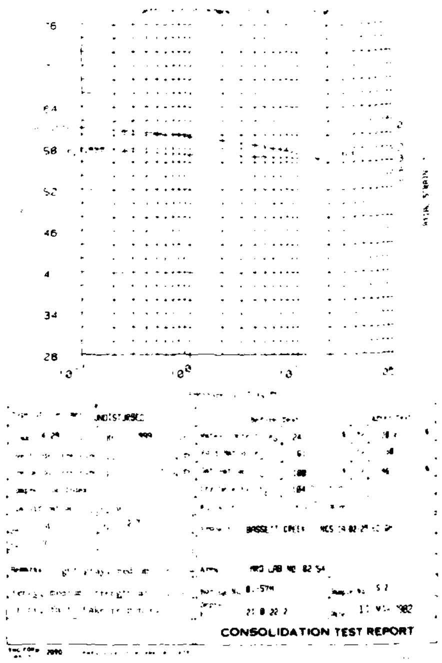
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
EDGEWOOD EMBANKMENT
BORING 81-57MU

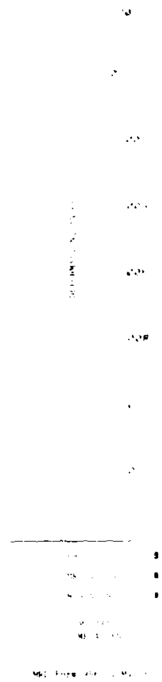
DATE: AUGUST 1982

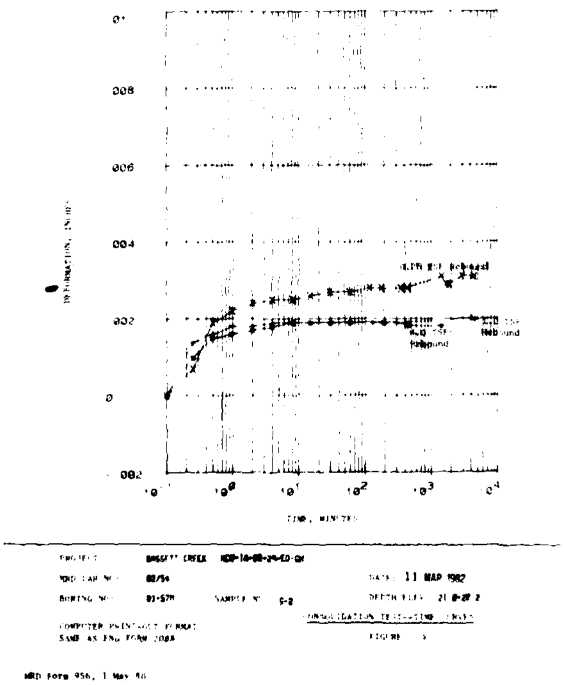
SCALE

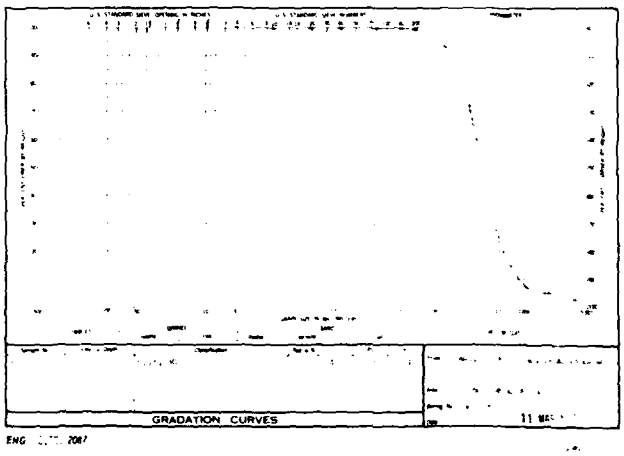
DRAWING NUMBER
M34.3-R-5/260
SHEET C-32 OF C-39

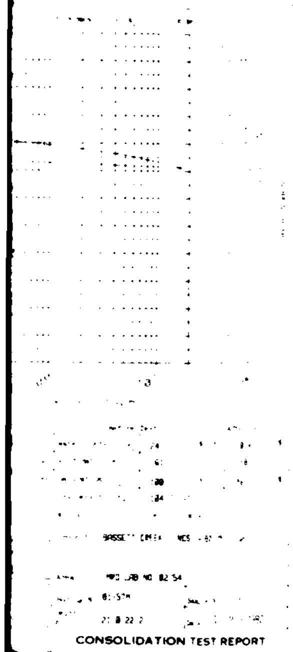

GRADATION CURVES
ENG FORM 2087
BASSETT CREEK
MRD LAB NO. 82/54

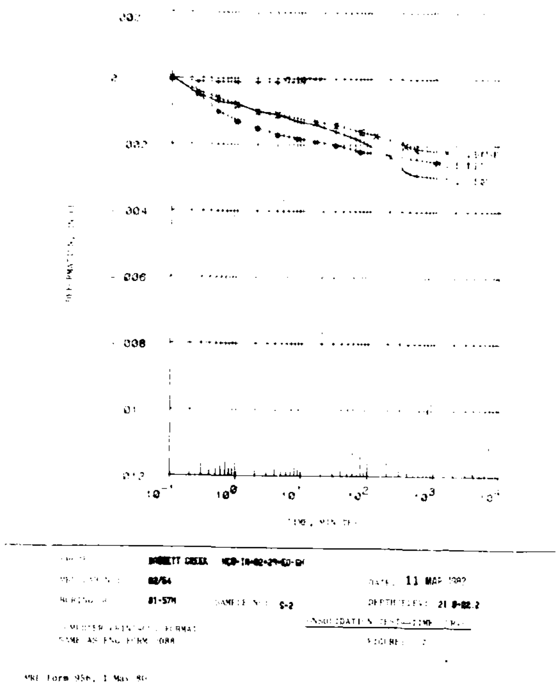

UNDISTURBED
BASSETT CREEK
MRD LAB NO. 82/54
11 MAR 1982
CONSOLIDATION TEST REPORT

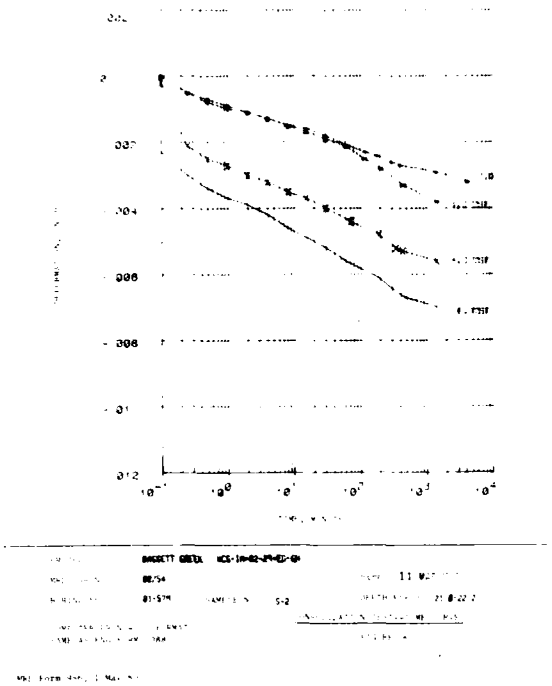


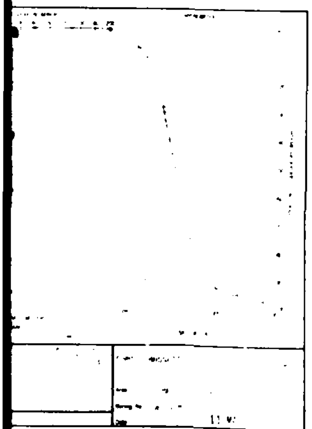

DEFORMATION, INCHES
TIME, MINUTES
Rebound
PROJECT: BASSETT CREEK
MRD LAB NO.: 82/54
DATE: 11 MAR 1982
BORING NO.: 81-57M
COMPUTER PRINTOUT FORMAT
SAME AS ENG FORM 2088
MRD Form 956, 1 May 80

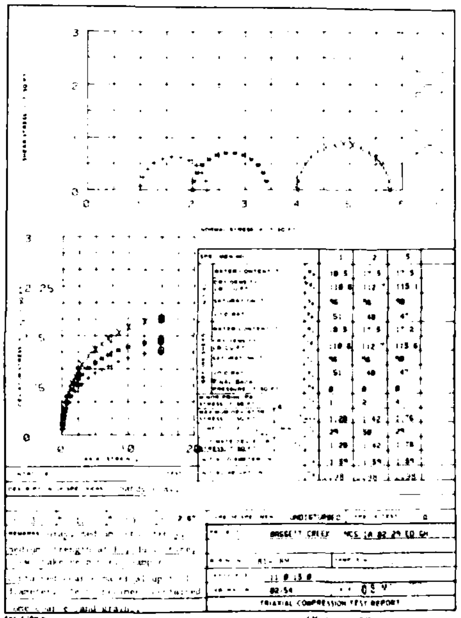

GRADATION CURVES
ENG FORM 2087

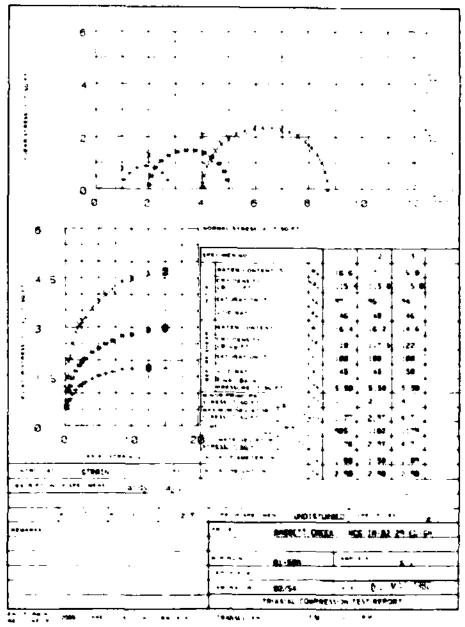












SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA

EDGEWOOD EMBANKMENT

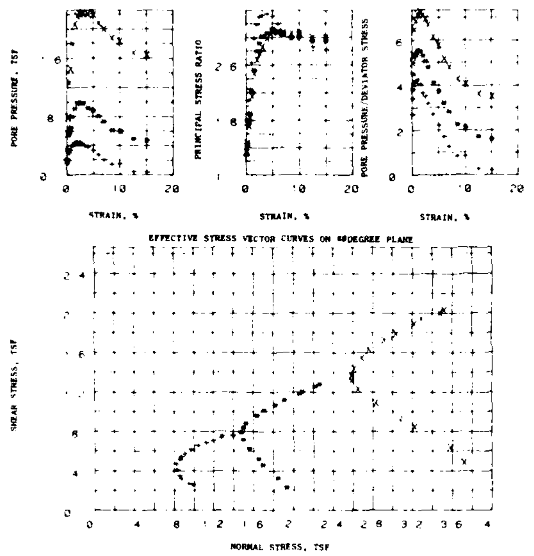
BORINGS 81-57MU & 81-58MU

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY
APPROVED:

DATE AUGUST 1982

DRAWING NUMBER
M34.3-R-5/261
SHEET C-33 OF C-39

2.



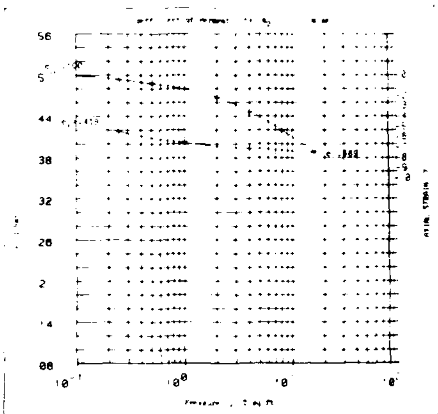
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

PROJECT:	BASSETT CREEK NCS IA 82-29-ED-GH
BORING NO:	81-58M
SAMPLE NO:	S-1
DEPTH/ELEV:	
MRD LAB NO:	82.54
DATE:	03 MAR 1982

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 7

MRD Form 756, 1 May 80



Type of Specimen: UNDISTURBED

	Before Test	After Test
Water Content	17.2 %	14.6 %
Void Ratio	.5	.42
Saturation	92 %	98 %
Dry Density	111.1	

Classification: Sandy clay

2.67

Remarks: Gray, medium consistency, medium strength, dull, shine

Project: BASSETT CREEK NCS-IA-82-29-ED-GH

Area: MRD LAB NO 82/54

Boring No: 81-58

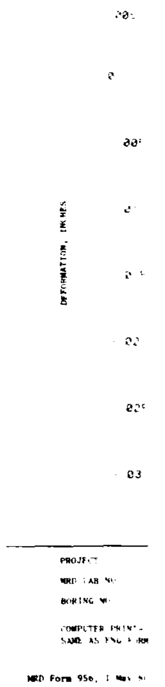
Sample No: S-1

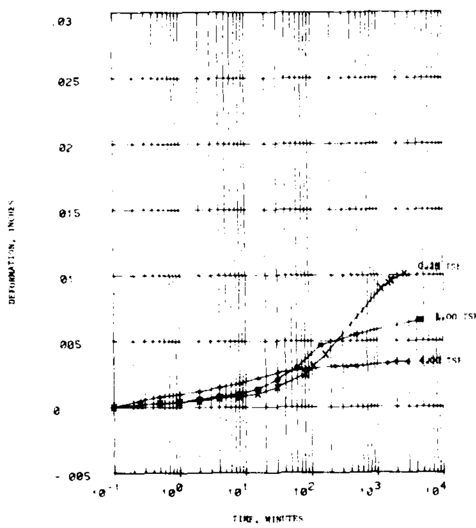
Date: 26 MAR 1982

CONSOLIDATION TEST REPORT

ENG FORM 2090

Figure





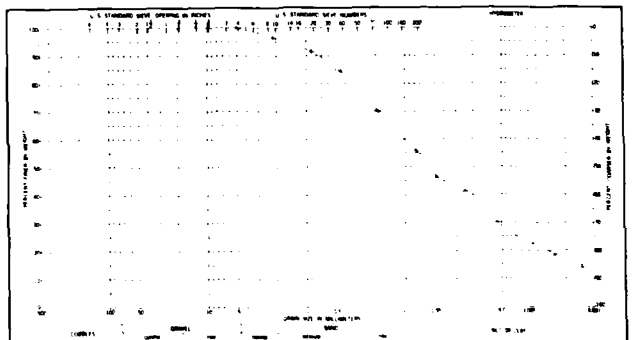
PROJECT:	BASSETT CREEK NCS-IA-82-29-ED-GH
MRD LAB NO:	82/54
BORING NO:	81-58
SAMPLE NO:	S-1
DATE:	26 MAR 1982
DEPTH/ELEV:	

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST--TIME CURVES

FIGURE: 4

MRD Form 956, 1 May 80

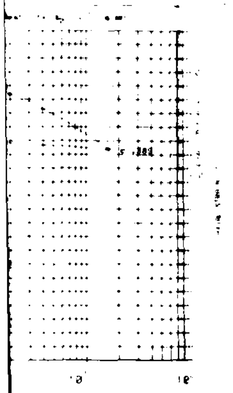


Sandy clay

GRADATION CURVES

Date: 03 MAR 1982

ENG FORM 2087



	Before Test		After Test
Water Content, w_o	17.2	w_f	
	5		
	92		
	111		

BASSETT CREEK NCS-IA-82-29-ED-GH

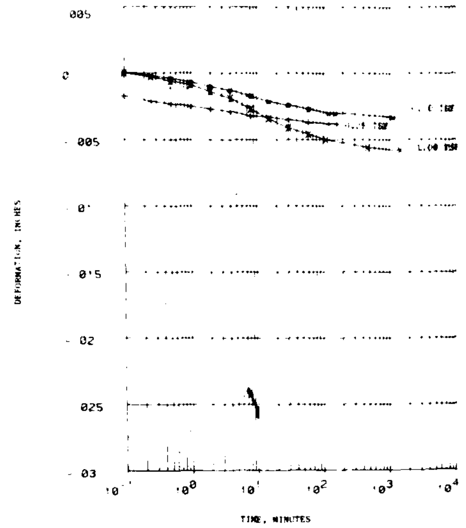
MRD LAB NO 82/54

81-58 | Sample No S-1

Date 26 MAR 1982

CONSOLIDATION TEST REPORT

Figure



PROJECT: BASSETT CREEK NCS-IA-82-29-ED-GH

MRD LAB NO: 82/54 DATE: 26 MAR 1982

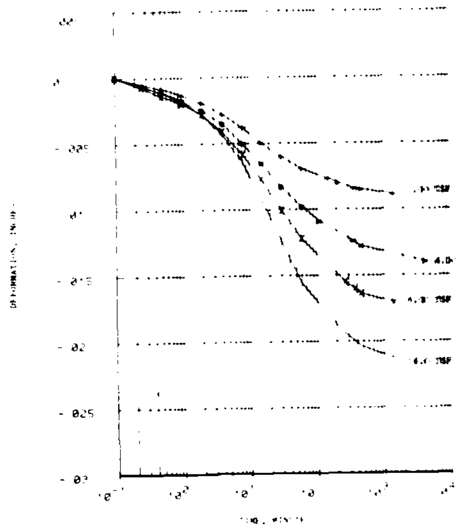
BORING NO: 81-58 SAMPLE NO: S-1 DEPTH/ELEV:

COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE:

MRD Form 956, 1 May 80



PROJECT: BASSETT CREEK NCS-IA-82-29-ED-GH

MRD LAB NO: 82/54 DATE: 26 MAR 1982

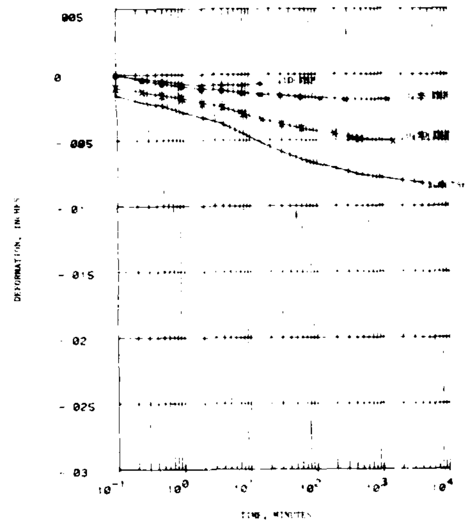
BORING NO: 81-58 SAMPLE NO: S-1 DEPTH/ELEV:

COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE

MRD Form 956, 1 May 80



PROJECT: BASSETT CREEK NCS-IA-82-29-ED-GH

MRD LAB NO: 82/54 DATE: 11 MAR 1982

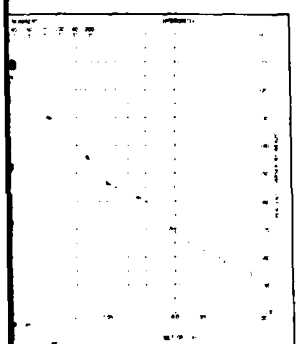
BORING NO: 81-58M SAMPLE NO: S-2 DEPTH/ELEV: 17.8-19.8

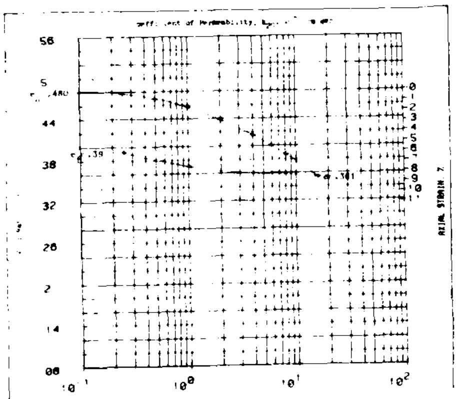
COMPUTER PRINT-OUT FORMAT SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE:

MRD Form 956, 1 May 80





Type of Specimen: UNDISTURBED

	Before Test		After Test
Water Content, w_o	17.5	w_f	15.1
Void Ratio, e_o	.48	e_f	.39
Saturation, S_o	95	S_f	100
Dry Density, γ_d	111.6		

Classification: Sandy clayey silt

Remarks: Gray, medium consistency, high strength at ... glossy shine, ... to pocket

Project: BASSETT CREEK NCS-IA-82-29-ED-GH

Area: MRD LAB NO 82/54

Boring No 81-58M | Sample No S-2

Depth 17.8-19.8 | Date 11 MAR 1982

CONSOLIDATION TEST REPORT

Figure 11

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA

EDGEWOOD EMBANKMENT

BORING 81-58MU

SUBMITTED BY:

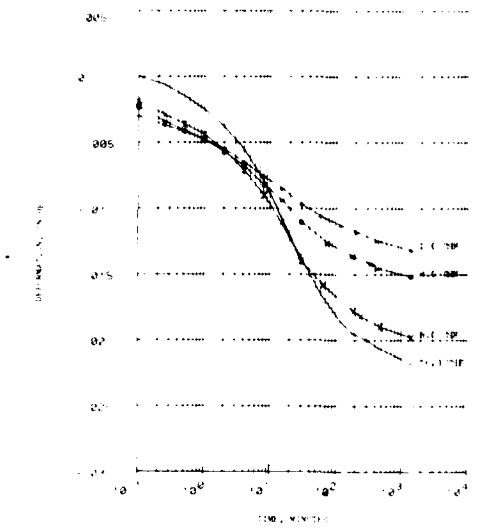
APPROVED:

DATE: AUGUST 1982

DRAWING NUMBER M34.3-R-5/262

SHEET C-34 OF C-39

2.



BASSETT CREEK NCS-IA-82-29-CO-GH

82/54 DATE: 11 MAR 1982

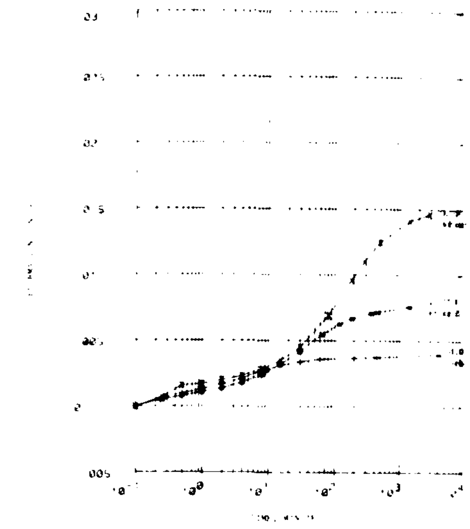
BORING NO. 81-58M SAMPLE NO.: S-2 DEPTH, ELEV.

CONSOLIDATION TEST--TIME

COMPUTER PRINTOUT FORMAT
SAME AS ENG FORM 2088

FIGURE

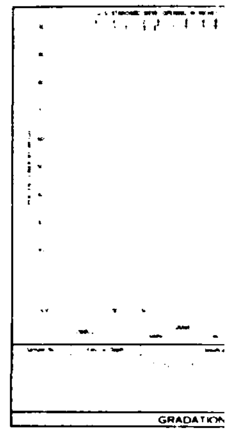
MRD Form 956, 1 May 80



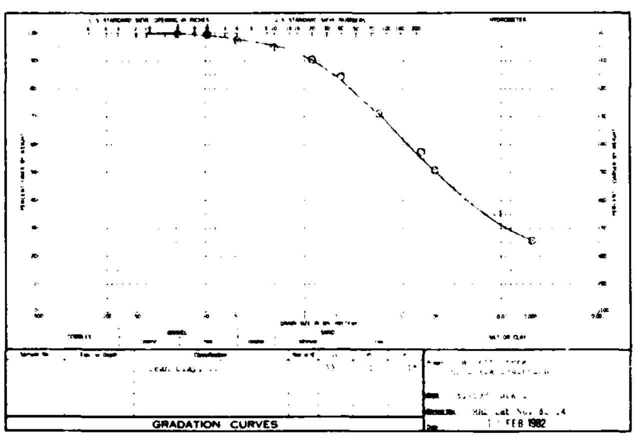
BASSETT CREEK

82/54 11 MAR 1982

81-58M S-2

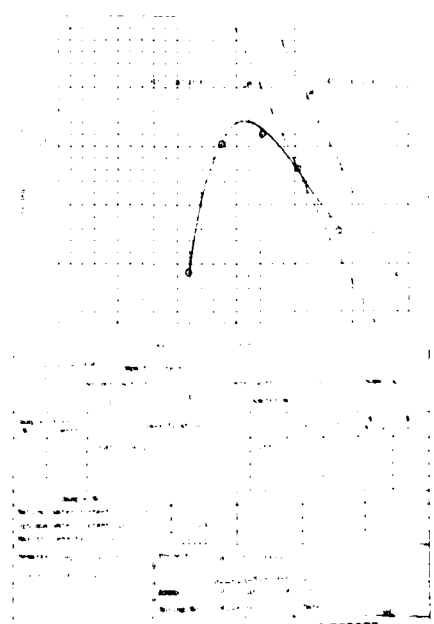


ENG 2087



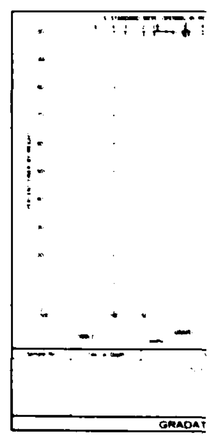
GRADATION CURVES

ENG 2087

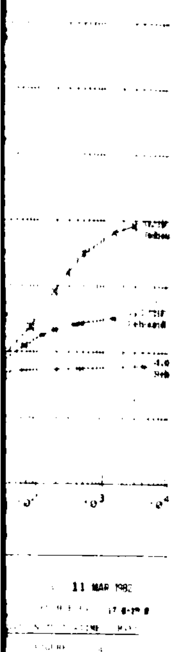


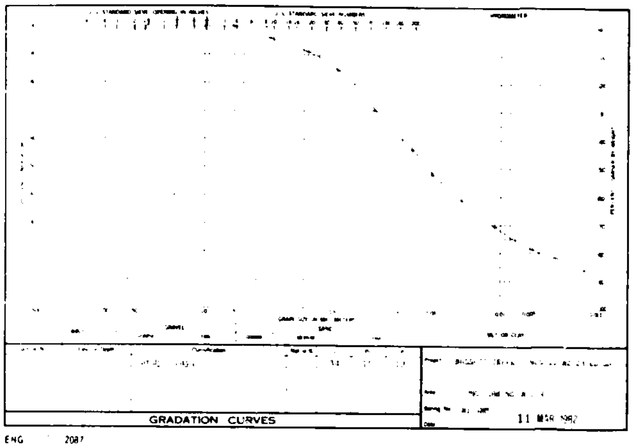
COMPACTION TEST REPORT

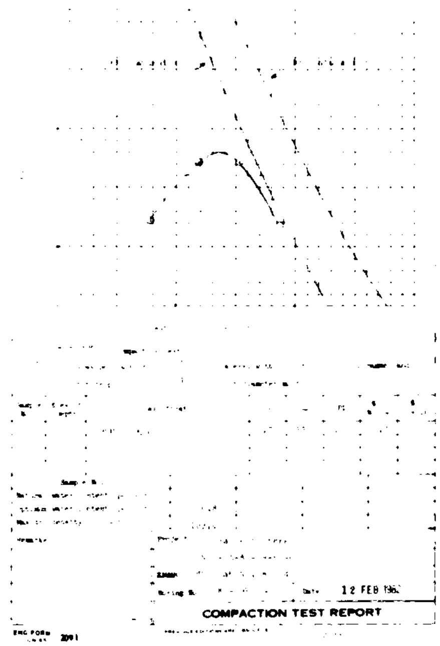
ENG FORM 2091

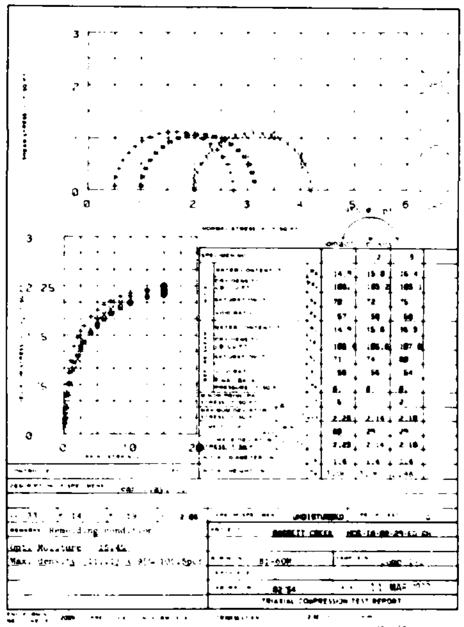


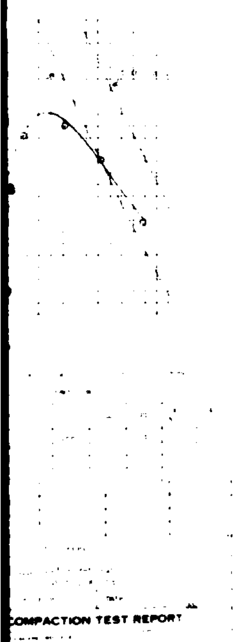
ENG 2087

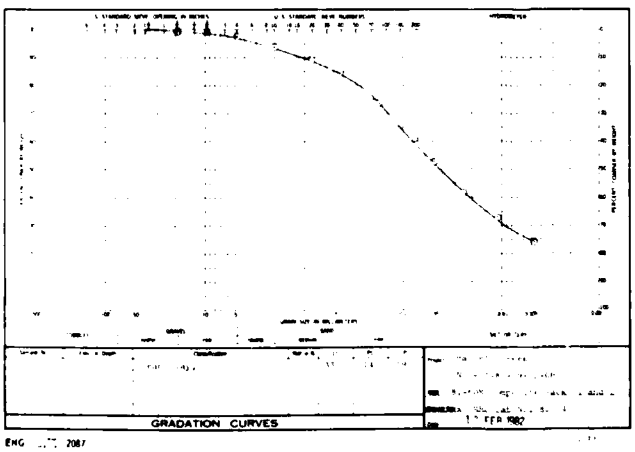












SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM

FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA

EDGEWOOD EMBANKMENT

BORINGS 81-58MU, 81-59MU & 81-60

DESIGNED BY:

DRAWN BY:

CHECKED BY:

SUBMITTED BY:

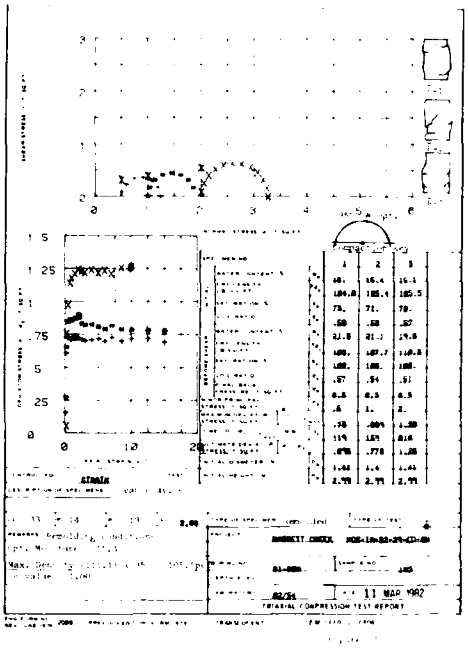
APPROVED:

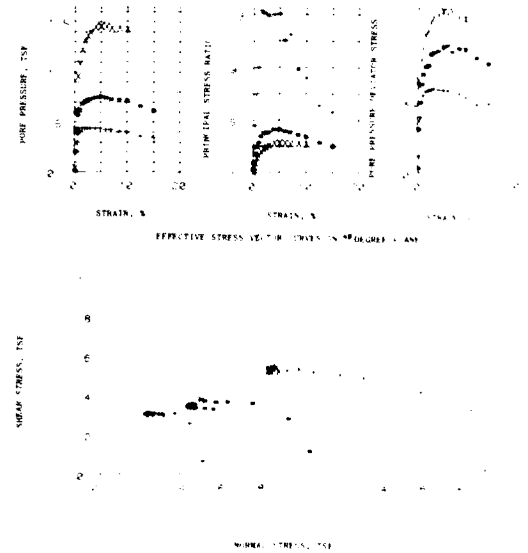
DATE: AUGUST 1982

DRAWING NUMBER: M34.3-R-5/263

SHEET C-35 OF C-39

2



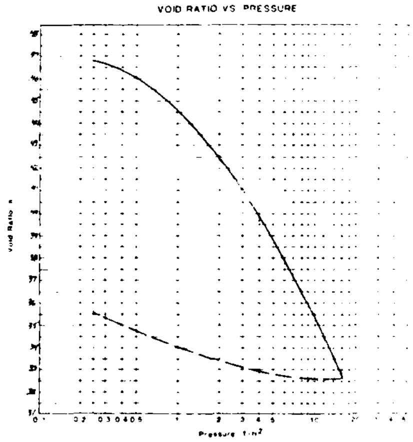


REMARKS
SYMBOLS SAME AS FORM 2089
TRIAXIAL TEST. PORE PRESSURE
MONITORED DURING SHEAR

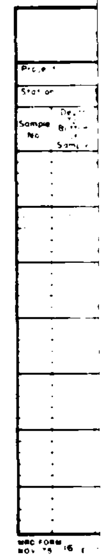
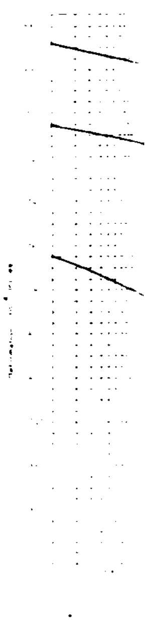
MRD Form 756, 1 May 80

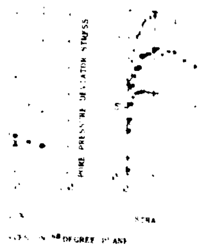
CONSOLIDATION TEST

VOID RATIO VS PRESSURE



Project	Bassett Creek	Date	
Job No.		Tested by	
Boring No.	B-R4	Original Moisture Content	
Sample No.	Shelby 11	Original Dry Density	
Depth	45.7'	Liquid Limit	
Initial Sample Height	0.75"	Plastic Limit	
Sample Diameter	2.5"	Overburden Pressure	
Description of Sample	Clay-Till	Preconsol. Pressure	
		Compression Index	

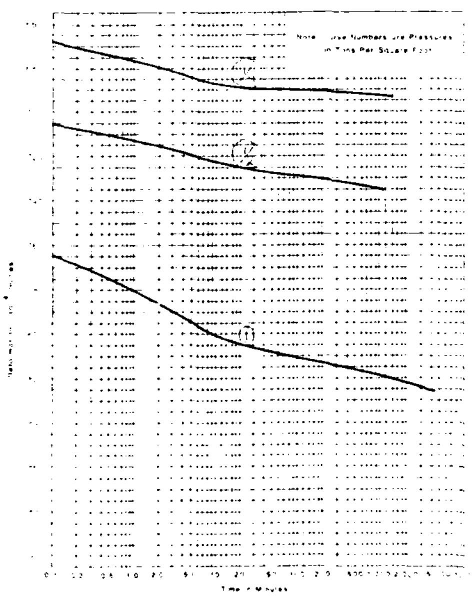


SOIL CLASSIFICATION RECORD SHEET

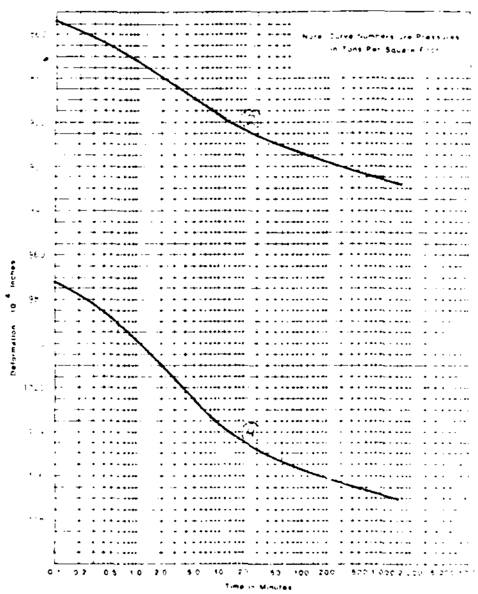
Project	Boring No	MRD Lab No
Station / Range / Surf Elev	Depth To Water Table	Bottom Of Hole

Sample No	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att Limits) L L	P	Grading (Cumulative Percents Finer)	Gradation Curve Analysis D_{60} mm	D_{10} mm	D_{30} mm	C_u	C_c	Classification Tech MEMO 3-357, May 67	Remarks

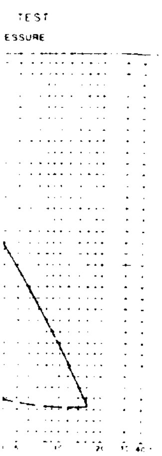
MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE



CONSOLIDATION TEST - TIME CURVES



CONSOLIDATION TEST - TIME CURVES



DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA

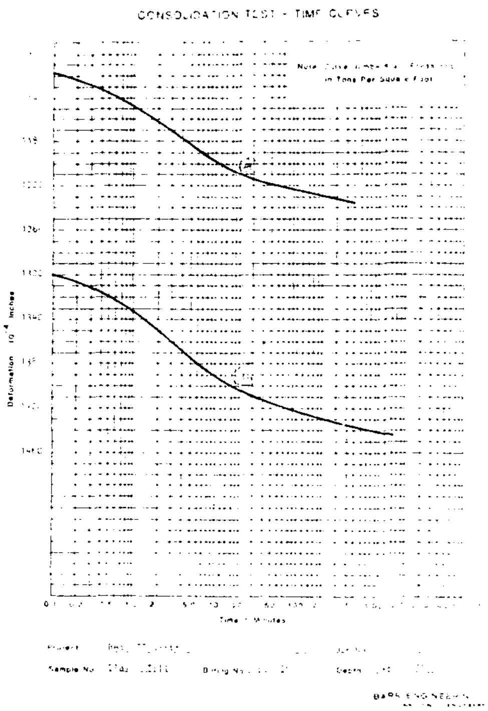
PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
EDGEWOOD EMBANKMENT
BORINGS 81-60M & BC-10C

SYMBOL | DESCRIPTION | DATE | APPROVAL

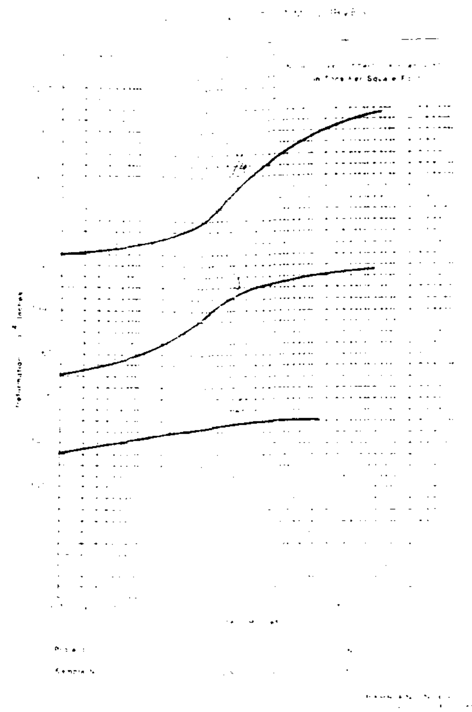
DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

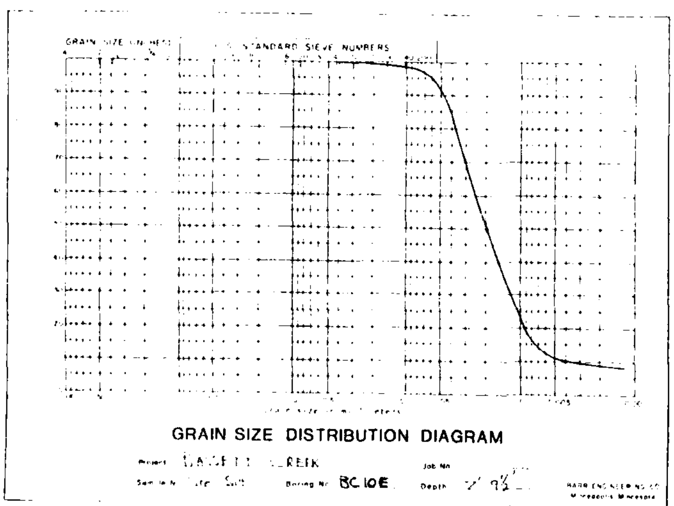
DATE
AUGUST 1982

DRAWING NUMBER
M34.3-R-5/264
SHEET C-36 OF C-39

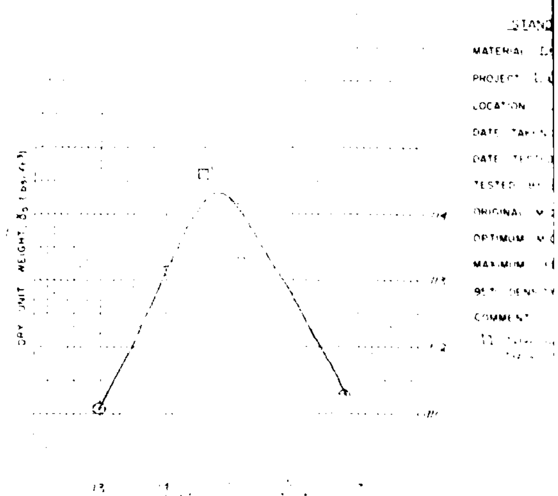


CONSOLIDATION TEST - TIME CURVES
Time in Minutes
BARR ENGINEERING

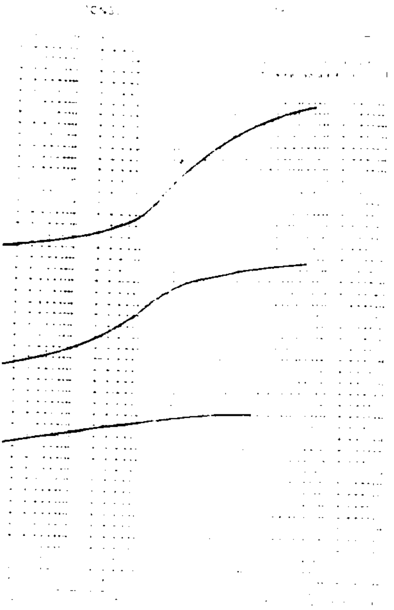


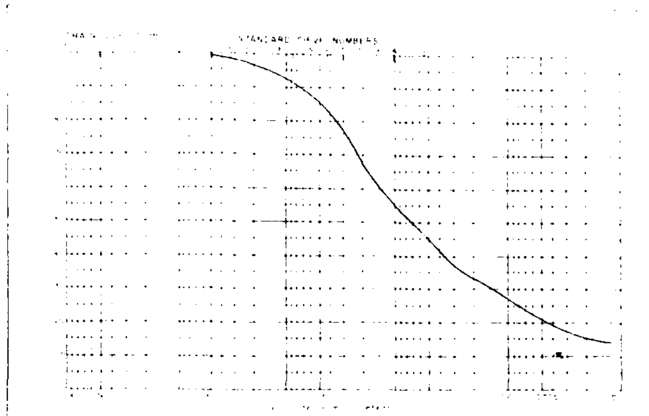


U.S. STANDARD SIEVE NUMBERS
GRAIN SIZE DISTRIBUTION DIAGRAM
Job No
Boring No BC 10E
Depth
BARR ENGINEERING CO.

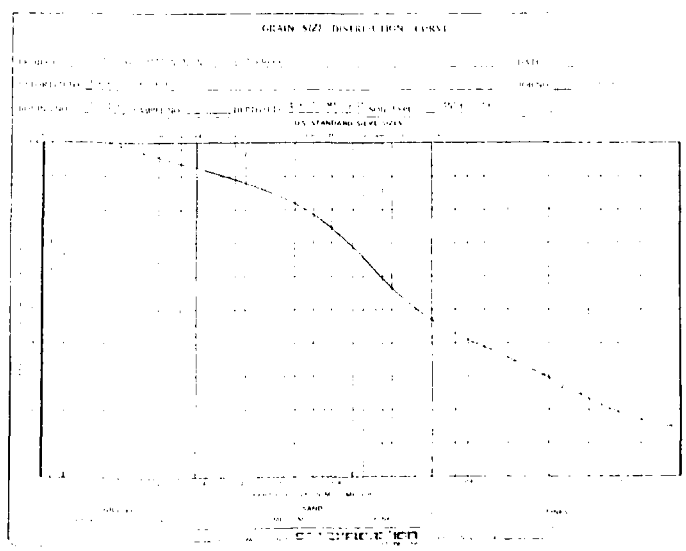


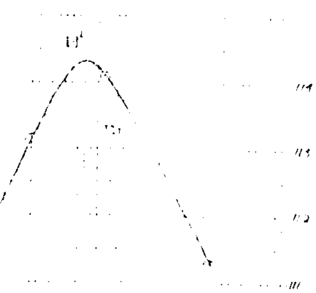
MATERIAL
PROJECT
LOCATION
COMMENT





GRAIN SIZE DISTRIBUTION DIAGRAM





STANDARD PROCTOR

MATERIAL Brown Clay BC 14D

PROJECT Bassett Creek

LOCATION

DATE TAKEN 3/26/80

DATE TESTED 4/1/80

TESTED BY DAS

ORIGINAL M.C (%)

OPTIMUM M.C (%) 17.0

MAXIMUM DENSITY (PCF) 111.3

95% DENSITY (PCF) 105.6

COMMENTS

BARR ENGINEERING CO

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
SOIL TEST DATA
EDGEWOOD EMBANKMENT
BORINGS BC-10C, BC-14D, BC-10E & BC-10B

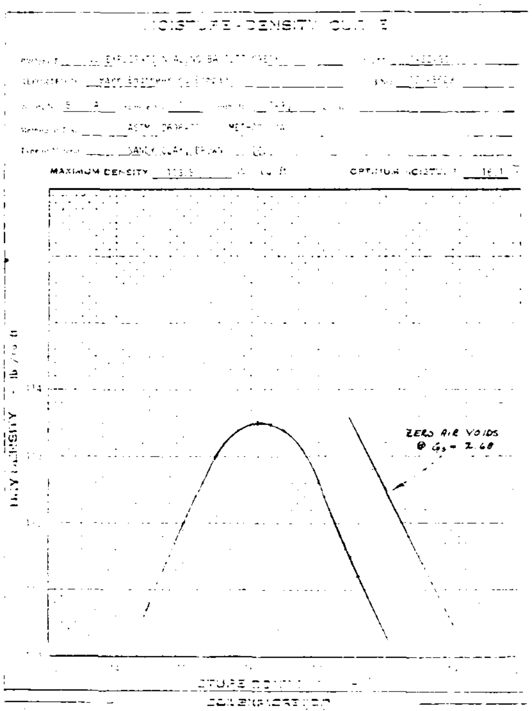
SUBMITTED BY:

APPROVED:

DATE: AUGUST 1982

DRAWING NUMBER
M34.3-R-5/265
SHEET C-37 OF C-39

2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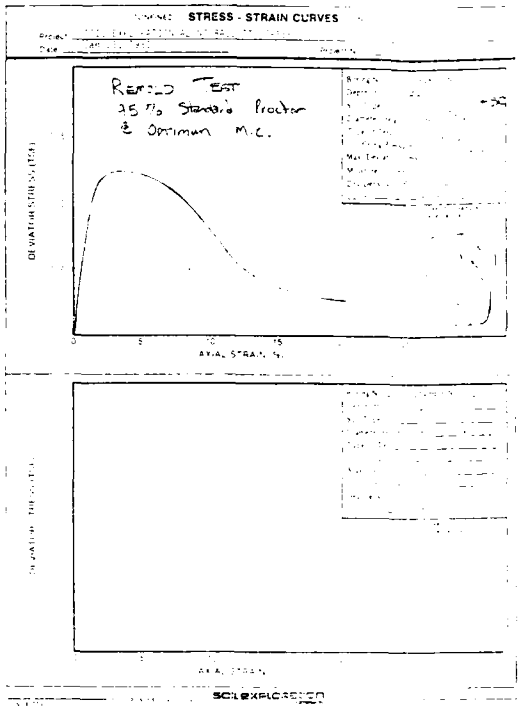
MAXIMUM DENSITY
OPTIMUM MOISTURE
DRY DENSITY
ZERO AIR VOIDS
@ G_s = 2.68
SOILEXPLORATION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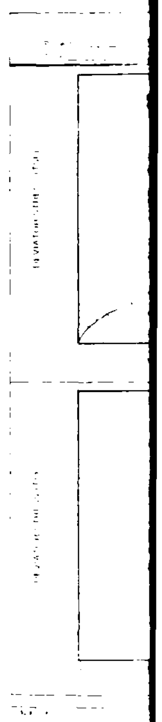
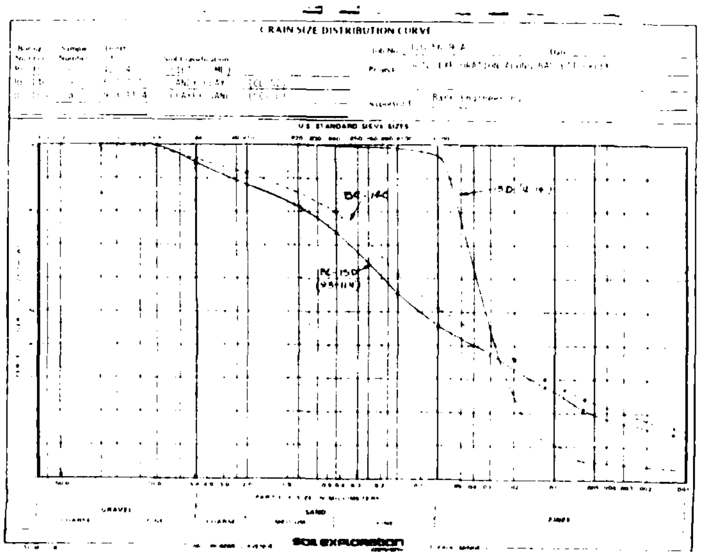
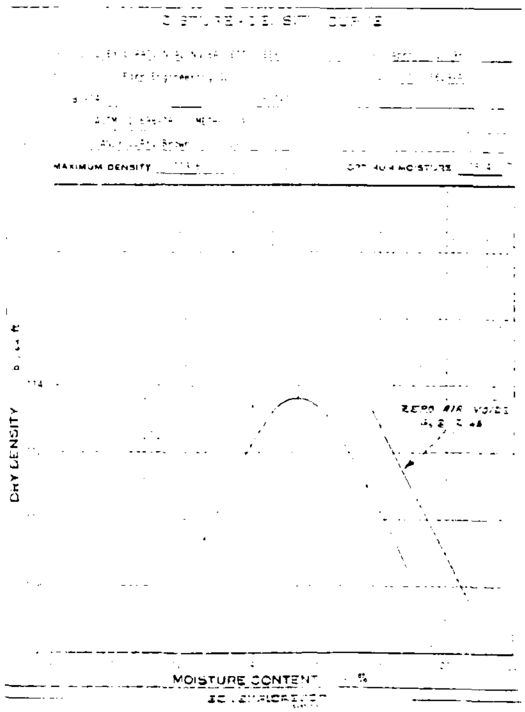
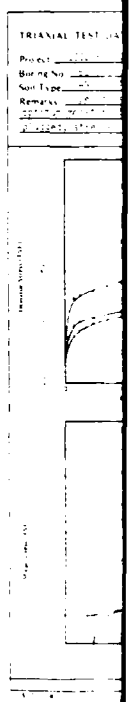
Remold Test
95 % Standard Proctor
@ Optimum M.C.
DEVIATOR STRESS
AXIAL STRAIN, %
SOILEXPLORATION

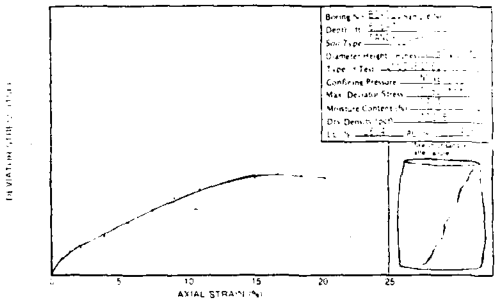


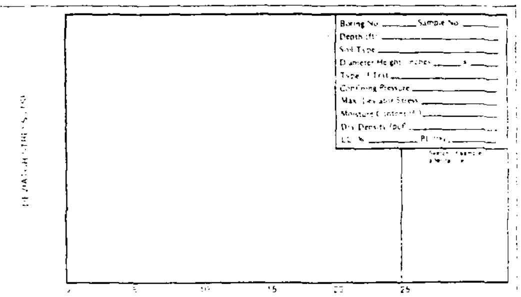

GRAIN SIZE DISTRIBUTION CURVE
U.S. STANDARD SIEVE SIZES
B4-14
B5-14
PC-150
GRAVEL
SAND
FINES
SOILEXPLORATION

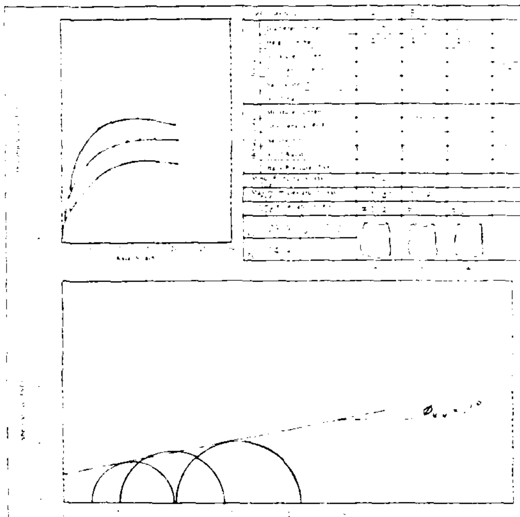

MOISTURE-DENSITY CURVE
MAXIMUM DENSITY
OPTIMUM MOISTURE
DRY DENSITY
ZERO AIR VOIDS
MOISTURE CONTENT %
SOILEXPLORATION


TRIAXIAL TEST

STRESS - STRAIN CURVES







SOIL EXPLORATION COMPANY

TRIAXIAL TEST DATA

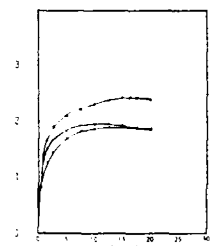
Date 4-29-80 Job No [illegible]

Project SOIL EXPLORATION ALONG BASSETT CREEK

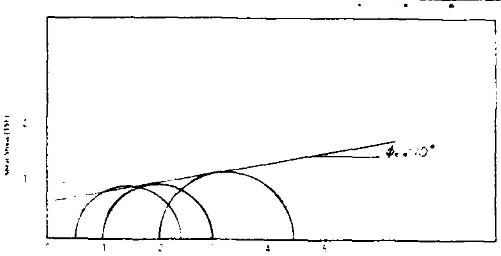
Boring No BC-14C Sample No ____ Depth (ft) 5.5-7.7 Type of Sample 3" "#"

Soil Type SANDY CLAY (CL-SC) Type of Test CU SATURATED

Remarks Specimens compacted to 95% of maximum standard proctor density and at 3% over optimum moisture content, drainage strips applied, Saturated and consolidated for 2 days, lines closed, stressed to given strains at constant rate of 0.0064"/min.



SPECIMEN NO		A	B	C
Initial	Diameter, inches	2.00	2.00	2.00
	Height, inches	4.00	4.00	4.00
	Moisture Content %	18.4	18.4	18.4
	Dry Density PCF	[illegible]	[illegible]	[illegible]
	Saturation %			
	Void Ratio			
Before Shear	Moisture Content %			
	Dry Density PCF			
	Saturation %	≈ 100	≈ 100	≈ 100
	Void Ratio			
	Back Pressure TSF			
Minor Principal Stress TSF		0.50	1.00	2.00
Maximum Deviator Stress TSF		1.97	1.86	2.44
Ultimate Deviator Stress TSF		≈ 1.98	≈ 1.55	≈ 2.41
LL	PI			
PL	Gs			



SOIL EXPLORATION COMPANY

TRIAXIAL TEST DATA

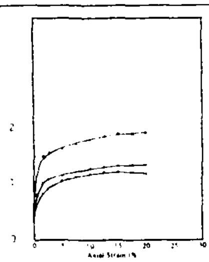
Date 4-30-80 Job No 120-5623-A

Project SOIL EXPLORATION ALONG BASSETT CREEK

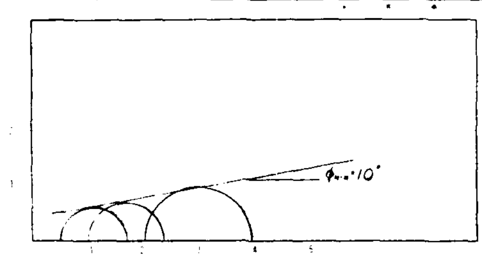
Boring No BC-14C Sample No ____ Depth (ft) 5.5-7.7 Type of Sample 3" "#"

Soil Type SANDY CLAY (CL-SC) Type of Test U-U (SATURATED)

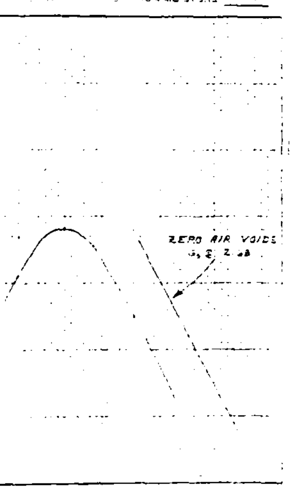
Remarks Specimens compacted 95% of maximum standard proctor density and at 3% over optimum moisture content, drainage strips applied, saturated for 2 days, drainage ends plugged, stressed to given strains at constant rate of 0.060"/min.



SPECIMEN NO		A	B	C
Initial	Diameter, inches	2.00	2.00	2.00
	Height, inches	4.00	4.00	4.00
	Moisture Content %	19.4	18.4	18.4
	Dry Density PCF	107.9	107.9	107.9
	Saturation %			
	Void Ratio			
Before Shear	Moisture Content %			
	Dry Density PCF			
	Saturation %	≈ 100	≈ 100	≈ 100
	Void Ratio			
	Back Pressure TSF			
Minor Principal Stress TSF		0.50	1.00	2.00
Maximum Deviator Stress TSF		1.23	1.35	1.94
Ultimate Deviator Stress TSF		≈ 1.19	≈ 1.35	≈ 1.72
LL	PI			
PL	Gs			



SOIL EXPLORATION COMPANY



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA

EDGEWOOD EMBANKMENT

BORINGS BC-10A, BC-10B, BC-10C & BC-14C

DATE AUGUST 1982

SCALE

DRAWING NUMBER M34.3-R-5/266

SHEET C-38 OF C-39

SAFETY PAYS

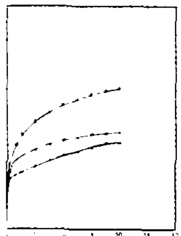
TRIAXIAL TEST DATA Date ______ Job No. 120-5629-A

Project: SOIL EXPLORATION ALONG BASSETT CREEK

Boring No. B-14 Sample No. ______ Depth (ft) ______ Type of Sample: BAG

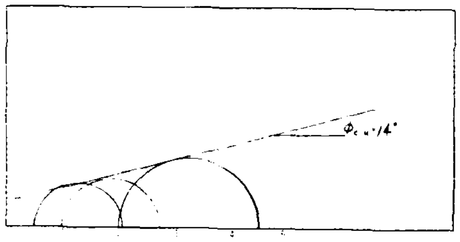
Soil Type: ______ Type of Test: ______ SATURATED

Remarks: Specimens compacted to ___ of maximum standard proctor density and at optimum moisture content, drainage strips applied, saturated and consolidated for 2 days, lines closed, stressed to given strains at constant rate of 0.0064 /min



SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	2.00	2.00	2.00
	Height (inches)	4.00	4.00	4.00
	Moisture Content (%)	15.4	15.4	15.4
	Dry Density (PCF)	107.9	107.9	107.9
	Saturation (%)			
	Void Ratio			
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)	≈ 100.0	≈ 100.0	≈ 100.0
	Void Ratio			
	Back Pressure (TSF)			
Minor Principal Stress (TSF)		0.50	1.00	2.00
Maximum Deviator Stress (TSF)		1.56	1.74	2.53
Ultimate Deviator Stress (TSF)		≈ 1.5	≈ 1.7	≈ 2.5

LL 30.9 PI 15.7 PL 15.2



SOIL EXPLORATION COMPANY

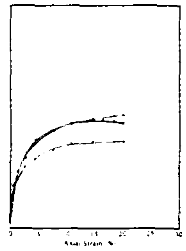
TRIAXIAL TEST DATA Date ______ Job No. ______

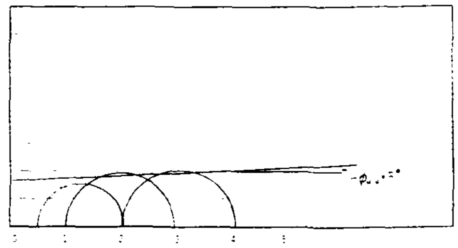
Project: SOIL EXPLORATION ALONG BASSETT CREEK

Boring No. ______ Sample No. ______ Depth (ft) ______ Type of Sample ______

Soil Type: SANDY CLAY ______ Type of Test ______

Remarks: Specimens trimmed to given sizes. Drainage strips applied, saturated for three days. Both drainage ends closed, stressed to given strains at constant rate of 2.060 /min.





SOIL EXPLORATION COMPANY

TRIAXIAL TEST DATA

Project ______ Boring No. ______ Soil Type ______ Remarks ______

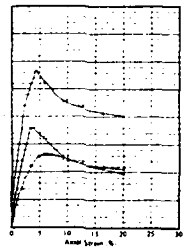
TRIAXIAL TEST DATA Date ______ Job No. 120-5629-A

Project: SOIL EXPLORATION ALONG BASSETT CREEK

Boring No. ______ Sample No. ______ Depth (ft) ______ (BOT) Type of Sample: 3" TWT

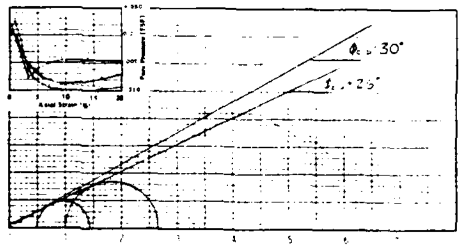
Soil Type ______ Type of Test: CIU with Pore Pressure

Remarks: Specimens trimmed to given sizes, drainage strips applied, saturated and consolidated for ___ days, lines closed, stressed to given strains at constant rate of ___ /min, pore pressure recorded throughout via transducer. Mohr circles based on maximum pore pressure.



SPECIMEN NO.		A	B	C
Initial	Diameter (inches)	1.38	1.38	1.38
	Height (inches)	2.75	2.75	2.75
	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)			
	Void Ratio			
Before Shear	Moisture Content (%)			
	Dry Density (PCF)			
	Saturation (%)	100	100	100
	Void Ratio			
	Back Pressure (TSF)	0.44	0.44	0.44
Minor Principal Stress (TSF)		0.50	1.00	2.00
Maximum Deviator Stress (TSF)		5.25	7.17	11.34
Ultimate Deviator Stress (TSF)		3.8	4.2	8.0

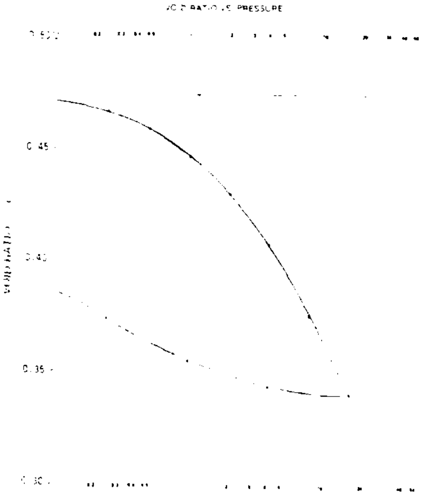
LL ______ PI ______ PL ______



SOIL EXPLORATION COMPANY ST. PAUL, MN

CONSOLIDATION TEST CURVE

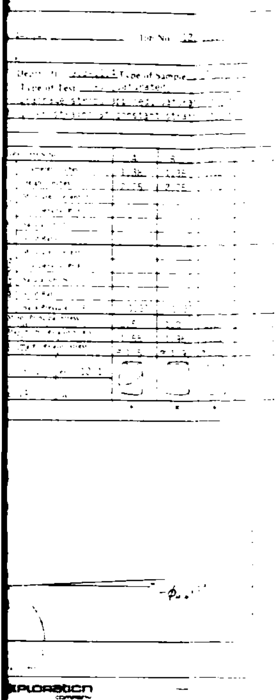
VOID RATIO VS PRESSURE

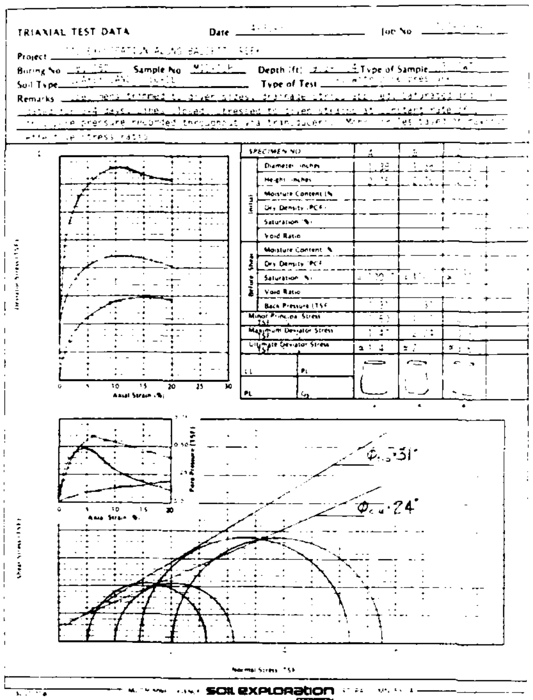


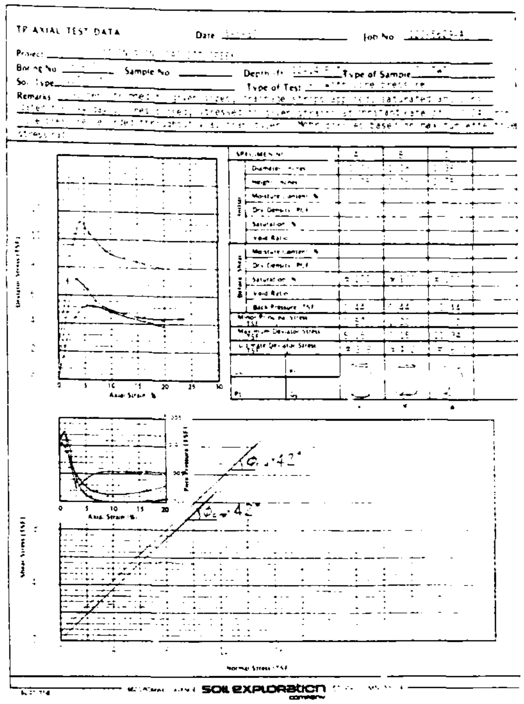
SOIL EXPLORATION ALONG BASSETT CREEK

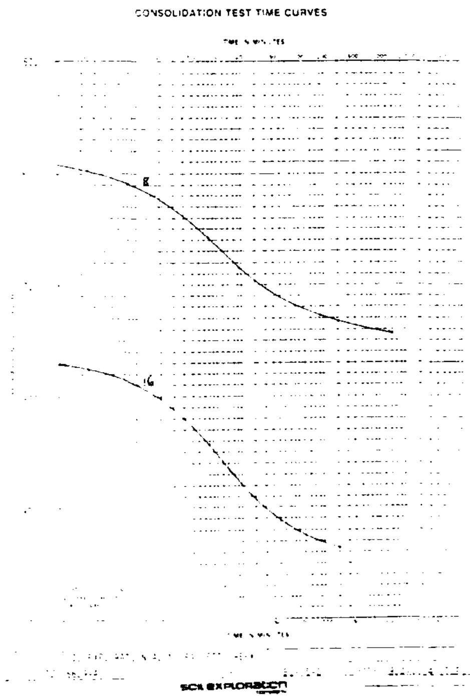
120-5629-A

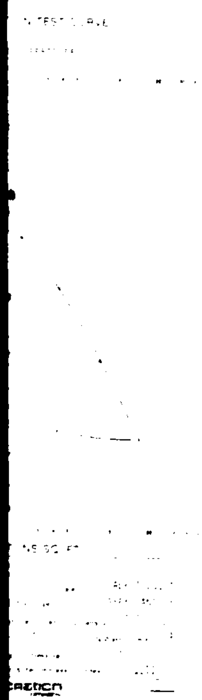
SOIL EXPLORATION COMPANY

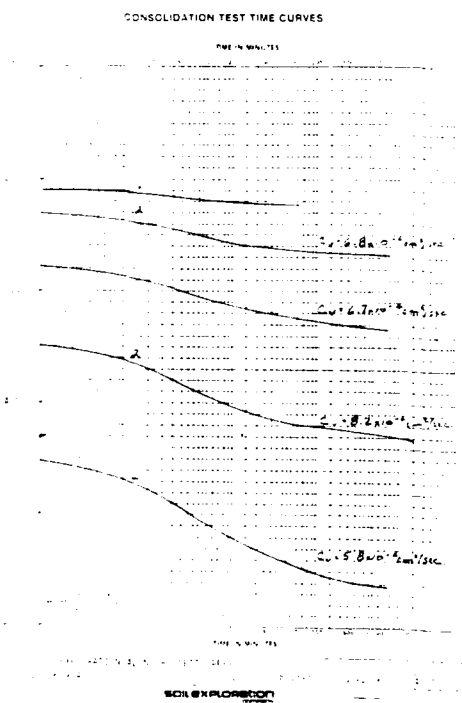












SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

PHASE II DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA

SOIL TEST DATA
EDGEWOOD EMBANKMENT
BORINGS BC-14C AND BC-15D

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SUBMITTED BY:
APPROVED:

DATE: AUGUST 1982

DRAWING NUMBER
M34.3-R-5/267
SHEET C-39 OF C-39

DEPARTMENT OF THE ARMY
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX D

STRUCTURAL

Table of Contents

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Tables

APPENDIX D

STRUCTURAL

1. This appendix describes the methods used in designing the retaining walls, drop structure, control structures, railroad bridge, tunnel, tunnel inlet structure, and interior drainage interceptors. Supporting information is included, such as design criteria, basic data and assumptions, loads and loading conditions.

DESIGN CRITERIA

2. WORKING STRESSES

Working stresses used in the design conform to those specified in Engineering Manual (EM) 1110-1-2101, dated November 1963, "Working Stresses for Structural Design", including changes 1 and 2. Loading conditions, design assumptions and other criteria are based on the applicable parts of the following references:

a. EM 1110-2-2000, Standard Practices for Concrete (including changes through 4, 30 July 1973).

b. EM 1110-2-2103, Details of Reinforcement and Hydraulic Structures (May 1971).

c. EM 1110-2-2902, Conduits, Culverts, and Pipes (including changes through 3, March 1969).

d. EM 1110-2-2906, Design of Pile Structures and Foundations (July 1958).

e. EM 1110-2-2502, Retaining Walls (including changes through 3, January 1965).

f. ETL 1110-2-265, Strength Design Criteria for Reinforced Concrete Hydraulic Structures (15 September 1981).

3. REINFORCED CONCRETE STRUCTURES

Reinforced concrete structures were designed by the strength method. The structures will be constructed of concrete having a 28-day minimum compressive strength of 4,000 pounds per square inch (psi).

4. CONCRETE REINFORCEMENT

Concrete reinforcement design was based on the use of deformed billet-steel bars conforming to the requirements of ASTM A615-72, Grade 40, with a minimum yield stress of 40,000 psi. Concrete cover and minimum reinforcement will comply with EM 1110-2-2103. The spacing, splicing and bending requirements of the bars will be in accordance with ACI-318-77 and the Manual of Standard Practice for Detailing Reinforced Concrete Structures.

5. ALUMINUM

Aluminum for the trash racks will be an alloy known commercially as 6061-T6. Working stresses used in the design in accordance with the EM 1110-1-2101.

6. STEEL SHEET PILING

Steel for sheet piling will conform to the requirements of the American Society for Testing Material A-328-75. The maximum working stress used in the design of sheet piling was limited to 0.5 Fy (yield strength) in accordance with Guide Specification CW-02411,February 1976. The yield strength of the sheet piling was assumed at 33,000 psi.

7. MISCELLANEOUS STRUCTURAL STEEL

Steel for miscellaneous structural steel will be in accordance with ASTM A-36. Working stresses for the design of structural steel will be in accordance with EM 1110-1-2101 for hydraulic structures.

SOILS DATA

8. SOILS CONSTANTS

Table 1 gives the soils constants of the foundation material used in the design of typical structures. The use of this soil data is explained in the description of the design of typical structures.

DESIGN OF STRUCTURES

9. GENERAL

The design of the retaining walls, drop structure, culverts, control structures, tunnel and tunnel inlet is described in the following paragraphs in sufficient details to explain the application of the design criteria and assumptions used.

10. RETAINING WALLS

The design of the cantilever sheet pile retaining walls in the Fruen Mill area was accomplished using computer program CSHTWAL (called X0031 in the CORPS Library). See Plates 15 and 17 for details. The walls were designed with the water at the design water surface elevation and at normal water surface elevation. The effect of the railroad was applied at the applicable section. The resulting pile penetration are those required for stability but increased by 20 percent.

11. DROP STRUCTURE

The drop structure's concrete thicknesses were designed to satisfy requirements for flexure and shear. Overturning stability, foundation pressures and sliding stability factor of safety were determined. For normal water surfaces, the sliding factor of safety is 3.8; for design water surface, the factor of safety is 3.0. Both satisfy the requirements of ETL 1110-2-256. The maximum soil pressure is .79 ksf which is well within the allowable soil pressure. See Plates 15 and 19 for the details of the drop structure.

TABLE 1

SOILS DATA
BASSETT CREEK

Location	Soil-Type Backfill	Ø	Moist pcf	Unit Weight Sliding Stab. Saturated pcf	C pcf	Ø	Bearing Capacity tsf
Highway 100	sand	35°	115	125	0	35	4*
Edgewood	clay	30°	121	128	750	10°	3
Golden Valley CC	clay	30°	121	128	750	10°	2
Highway 55	sand	30°	115	125			2

*Excavate beneath structure

Location	Soil-Type Backfill	Ø	Moist pcf	Saturated pcf	C pcf	Ø	Bearing Capacity tsf
Tunnel	Qmq (CH)		106	43.6	600	20°	
	Qmz (SP)			130		30°	
	Quvf (CL)			125	1500-2000	27°	
	Soft (CH)			106	500	20°	
Medicine Lake	OL			87		34	
	SC			140-145++		35°-37°++	
	CL			134-140++		32°++	
	OH			85++		34°++	
	SC-SM			145++		37°++	
Fruen Mill	Sand Backfill		120	130		30	
	Foundation		120	130	0	27	
			120	130	4000	0	

++ Estimated.

12. RAILROAD BRIDGE

The railroad bridge was designed according to the applicable portions of the American Railway Engineering Association (AREA) Manual for Railway Engineering. See Plates 15 and 19 for details. Two different bridges were designed to determine the most cost effective structure. A single span welded plate girder bridge proved to be more expensive than a two span rolled girder bridge. Both alternatives were analyzed using the computer program Analysis and Rating of Plate Girder Bridges (called X0045 in the CORPS Library). The abutment was designed for at-rest conditions. Pile loads were determined by the classical method. The pile penetration was determined by skin friction.

The concrete dimensions of the intermediate pier were checked for flexure and shear. The pile penetration was determined assuming that the piles are friction piles.

The bridge was designed for a Cooper E-80 loading but after discussions with the Minneapolis Northfield and Southern Railroad they felt that designing for Copper E-60 would be adequate. The bridge is on a spur line and due to the condition of the roadway, train speeds do not exceed 10 miles per hour.

13. TUNNEL

The design of the tunnel was of a preliminary nature since a Feature Design Memorandum will be prepared for this feature. Three different tunnel sections were designed using loads determined by the formulas presented in "Analysis of Ground Liner Interaction for Tunnels" prepared for the U.S. Department of Transportation by the University of Illinois. The report is dated October 1978. The loads were used in the computer program "NEWTUN" (X0055 in the CORPS Library) to determine the moments, shears and axial loads for the design of the tunnel lining. The Feature Design Memorandum will explore precast vs. cast-in-place tunnel liners. See Plate 8 for the different tunnel sections.

14. TUNNEL INLET

The tunnel inlet was not designed but was drawn based upon experience with similar structures that have been used successfully in the past. See Plate 9 for the site plan and details.

15. CONTROL STRUCTURES

The control structures' concrete thicknesses were designed for flexure and shear. Overturning stability was checked and the foundation pressures were determined. All were within the allowables. The design computations are not included since they are similar to the drop structure computations.

16. CULVERTS

All culverts were designed according to EM 1110-2-2902. The precast reinforced concrete culverts will have watertight joints. Wherever the culvert is used at an embankment, the culvert will have tied joints. The design of the precast box culvert was based upon ASTM D 789.

17. MEDICINE LAKE CONTROL STRUCTURE

The control structure is a sheet pile weir capped with concrete. See Plate 34 for details. The computer program "Soil Structure Interaction Analysis of Sheetpiles"(X0060 in the CORPS Library) was used for the analysis due to the multi-layered soils. A penetration into the sand layer was assumed and then bending moments, shears and deflections were computed.

18. 215 WORK ITEMS

The design computations for structures covered under the 215 agreement have previously been submitted.

19 TYPICAL DESIGN COMPUTATIONS

	Pages
Drop Structure	D6 - D23
Retaining Wall	D24 - D33
Railroad Bridge	D34 - D66
Medicine Lake Control Structure	D67 - D70
Tunnel Design	D71 - D100

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 69)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 1 OF 2	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek - Drop Structure near Fruen mill	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	

Concrete Weights

Sym	Factors	+↓ Forces (Lb)	+→	Arm (Ft)	↻+ Moments (Ft-Lb)	↺
C_1	25'(37')(2')(150 Lb/Ft³)	277,500		12.5	3,468,750	
C_2	30'(5.7')(1')(150 Lb/Ft³)	25,650		19.5	500,175	
C_3	30'(0.9')(1')(150 Lb/Ft³)	4,050		5.5	22,275	
C_4	25'(12.4')(1.5')(150 Lb/Ft³)	69,750		12.5	871,875	
C_5	25'(7.4')(1.5')(150 Lb/Ft³)	41,625		12.5	520,313	
C_6	½(7.5')(2.5')(1.5')(150)	2,109		11.0	23,203	
C_7	11.5'(2.5')(1.5')(150)	6,469		19.25	124,523	
C		427,153		12.949	5,531,114	

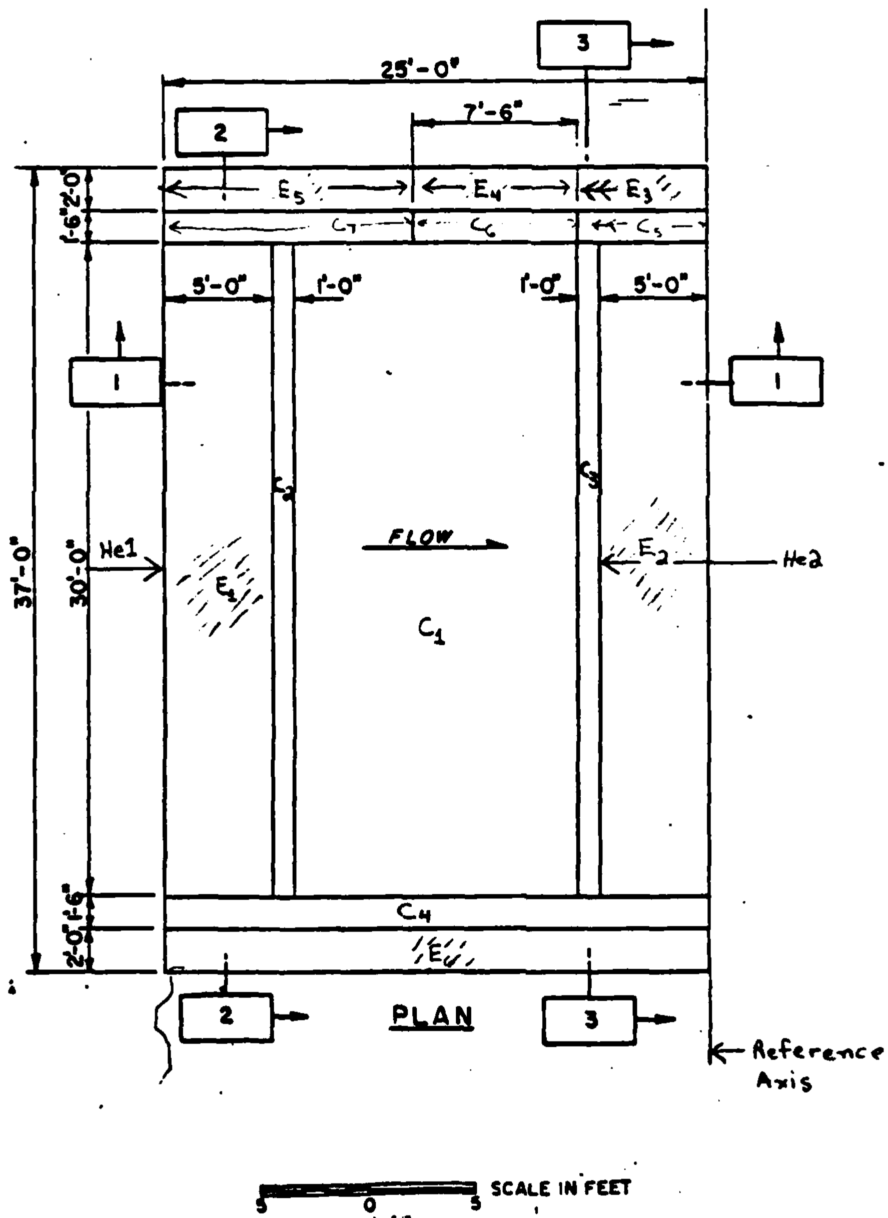
Case 1) Construction Case (No water) $\gamma_M = 120$ Lb/Ft³, $\gamma_{SAT} = 125$ Lb/Ft³, $\phi = 30°$

Sym	Factors	+↓ Forces (Lb)	+→	Arm	↻+ Moments (Ft-K)	↺
E_1	30'(5')(2.4')(120 Lb/Ft³)	43,200		22.5	972,000	
E_2	30'(5')(0.9')(120 Lb/Ft³)	16,200		2.5	40,500	
E_3	25'(7.4)(2')(120 Lb/Ft³)	44,400		12.5	555,000	
E_4	½(7.5')(2.5')(2')(120)	2,250		11.0	24,750	
E_5	11.5'(2.5')(2') 120 Lb/Ft³	6,900		19.25	132,825	
E_6	25'(12.4')(2')(120 Lb/Ft³)	74,400		12.50	930,000	
He1	$\frac{(120 \text{ Lb/Ft}^3)(4.4')^2}{2}(0.5)(30')$		17,424	1.47		-25,555
He2	$\frac{(120)(2.9)^2}{2}(0.5)(30)$		-7,569	0.97	7,317	
C	(See above)	427,153		12.949	5,531,114	
		614,503	9,855		8,193,506	-25,555

$\Sigma M = 8,167,951$

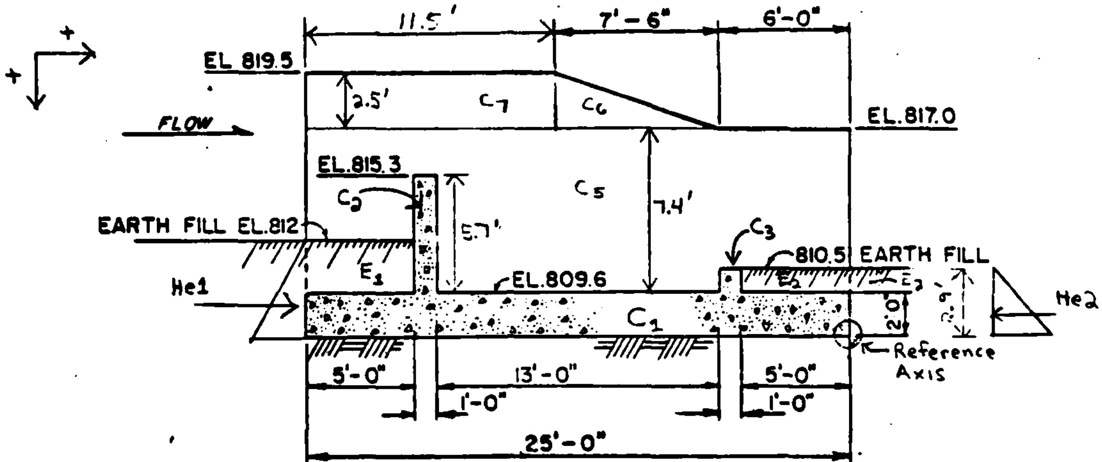
$He1 = \frac{\gamma_m H^2}{2} \cdot K_o \cdot L$

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 2 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek Drop Structure near Fruen mill	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	

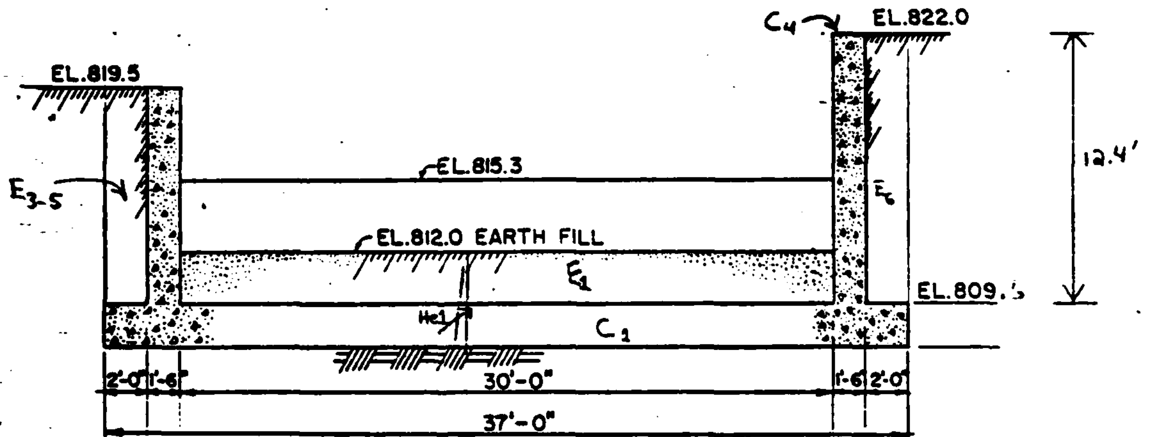


NCS 14

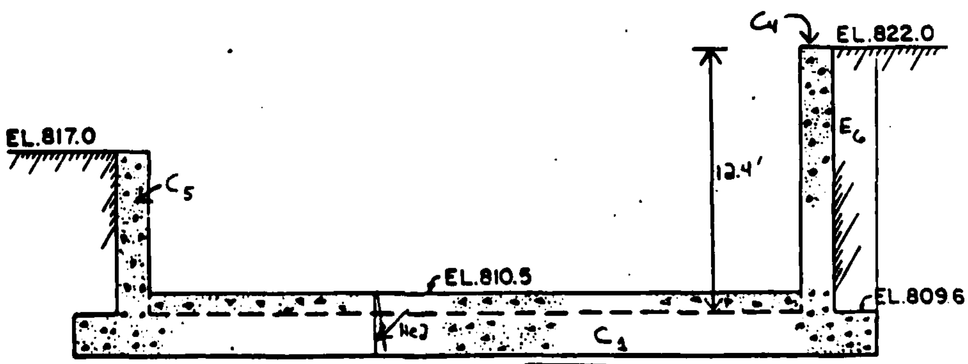
ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 3 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek Drop structure near Fruen mill	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	



SECTION 1



SECTION 2



SECTION 3

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 63)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 4 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek Drop Structure near Fruen mill	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	

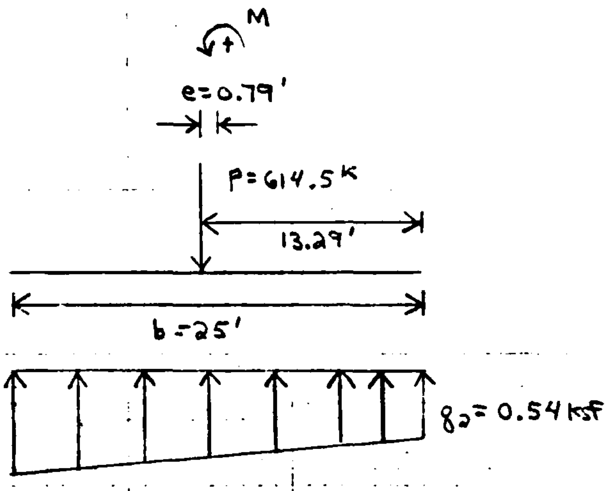
– Find Soil Pressure for Case 1

(See pg 8-64 "CE Handbook")

$$\text{arm} = \frac{\Sigma M}{\Sigma V} = \frac{8,167,951}{614,503} = 13.29$$

(in Kern)

$A = 25' \times 37' = 925 \text{ ft}^2$



$$q_1 = \frac{P}{A}\left(1 + \frac{6e}{b}\right)$$

$$q_2 = \frac{P}{A}\left(1 - \frac{6e}{b}\right)$$

$$q_1 = \frac{614.5^K}{925 \text{ ft}^2}\left(1 + \frac{6(0.79')}{25'}\right) = 0.79 \text{ ksf}$$

$$q_2 = \frac{614.5}{925}\left(1 - \frac{6(0.79)}{25}\right) = 0.54 \text{ ksf}$$

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 5 OF 13	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	

– Case 2) Pool = 815.8, T.W. = 811.0, $\gamma_M = 120$ Lb/Ft³, $\gamma_{sat} = 125$ Lb/Ft³

$He1 = \frac{\gamma_{sub} H^2}{2} \cdot K_o \cdot L$

$Hw1 = \frac{1}{2} \gamma_w H^2 \cdot L$

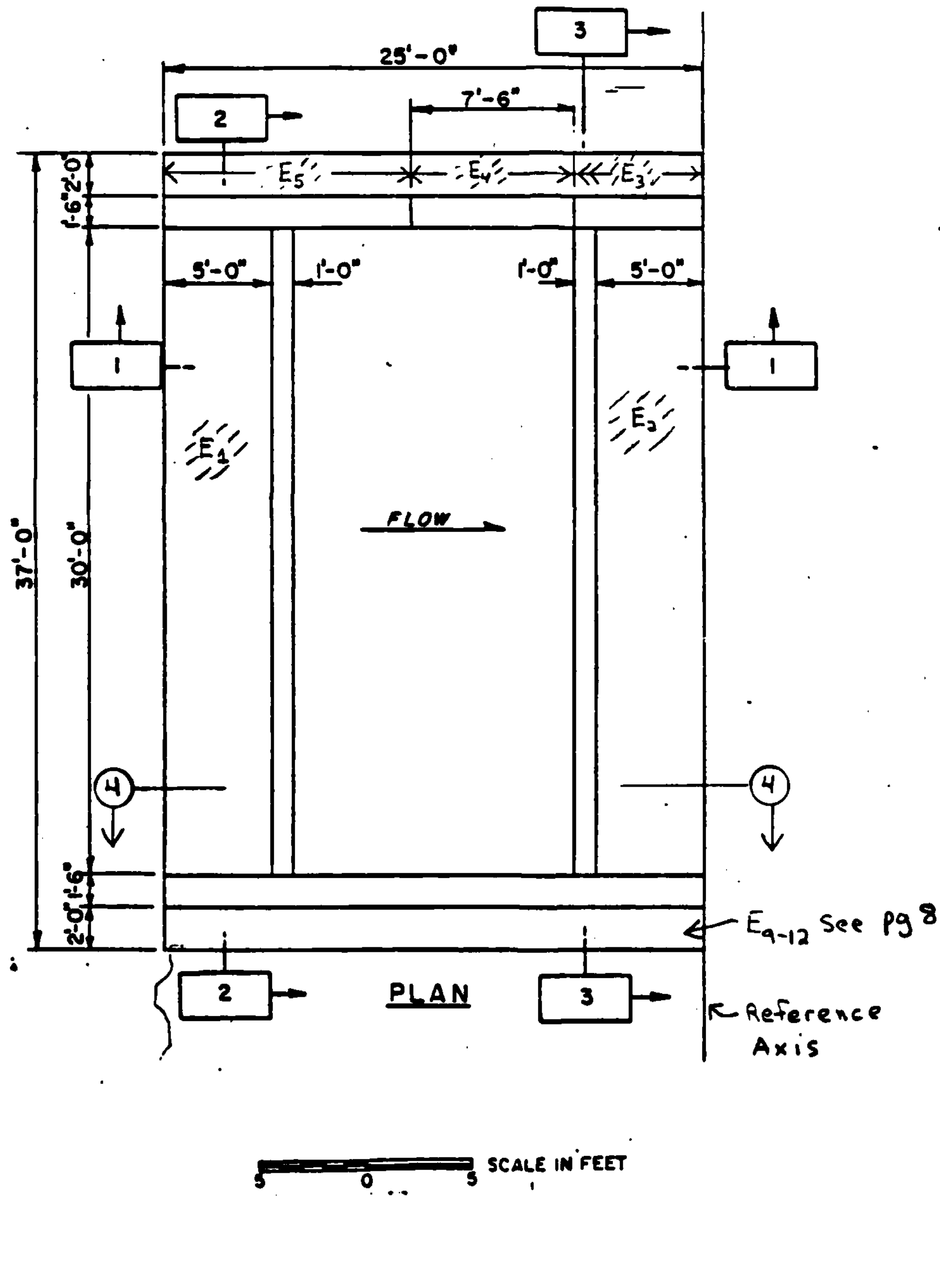
$\phi = 30°$, $\gamma_{sub} = \gamma_{sat} - \gamma_{water}$

$= 125 - 62.5 = 62.5$ Lb/Ft³

Sym	Factors	+↓ Forces (Lb)	+→	Arm (Ft)	(+) Moments (Ft-Lb)	(−)
C	(See pg 1)	427,153		12.949	5,531,114	
E_1	5'(30')(2.4')(62.5 Lb/Ft³)	22,500		22.5	506,250	
E_2	5'(30')(0.9')(62.5 Lb/Ft³)	8,438		2.5	21,094	
E_3	2'(25')(1.4')(62.5 Lb/Ft³)	4,375		12.5	54,688	
E_4	½(4.8')(25')(2')(62.5)	7,500		⅔(25)	125,000	
E_5	½(4.8')(25')(2')(120)	14,400		⅓(25')	120,000	
E_6	2'(1.2')(25')(120 Lb/Ft³)	7,200		12.5	90,000	
E_7	½(7.5')(2.5')(2')(120)	2,250		11.0	24,750	
E_8	2'(2.5')(11.5')(120)	6,900		19.25	132,825	
E_9	1.4'(2')(25')(62.5)	4,375		12.5	54,688	
E_{10}	½(25')(4.8')(2')(62.5)	7,500		⅔(25)	125,000	
E_{11}	½(25')(4.8')(2')(125)	15,000		⅓(25)	125,000	
E_{12}	2'(25')(6.2')(120)	37,200		12.5	465,000	
W_1	5'(30')(6.2')(62.5) γ_{water}	58,125		22.5	1,307,813	
W_2	(5.5')(30')(1.4')(62.5)	14,438		16.25	234,609	
W_5	½(5.5')(4.8')(30')(62.5)	24,750		17.17	424,875	
W_3	(7.5')(30')(1.4')(62.5)	19,688		9.75	191,953	
W_6	(5')(0.9')(30')(62.5)	8,438		2.5	21,095	
W_4	6'(30')(0.5')(62.5 Lb/Ft³)	5,625		3.0	16,875	
He1	$\frac{(62.5 \text{ Lb/Ft}^3)(4.4')^2}{2}(0.5)(30')$		9,075	⅓(4.4')		−13,310
He2	$\frac{(62.5)(2.9)^2}{2}(0.5)(30')$		−3,942	⅓(2.9)	3,811	
Hw1	$\frac{1}{2}(62.5 \text{ Lb/Ft}^3)(8.2)^2(30')$		63,038	⅓(8.2')		−172,303
Hw2	$\frac{1}{2}(62.5)(3.4)^2(30')$		−10,838	⅓(3.4)	12,283	
U_1	(See pg 9)	−196,562		12.5		−2,457,025
U_2	(See pg 9)	−138,750		⅔(25')		−2,312,500
		360,543	57,333		9,588,722	−4,955,138

NCS 14
1 JUNE 79 (REPLACES NCD 14 1 APR 68)

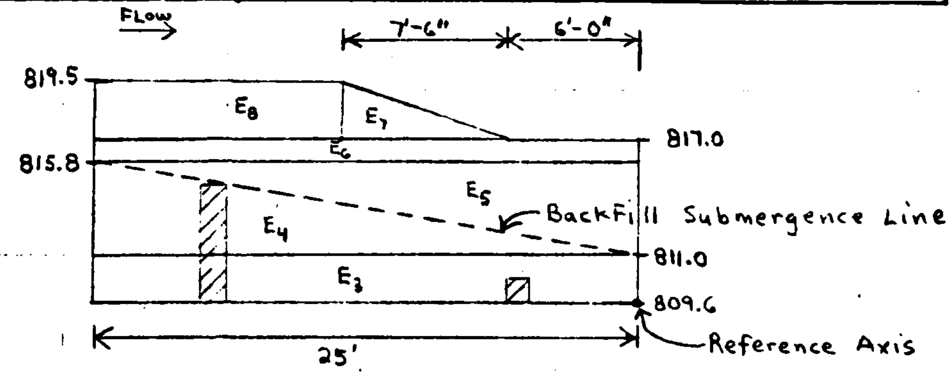
ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 6 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	



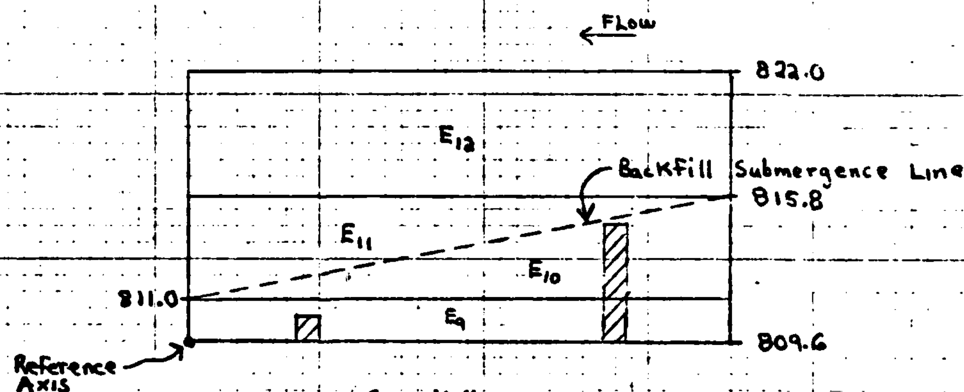
PLAN

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 63)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 7 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	



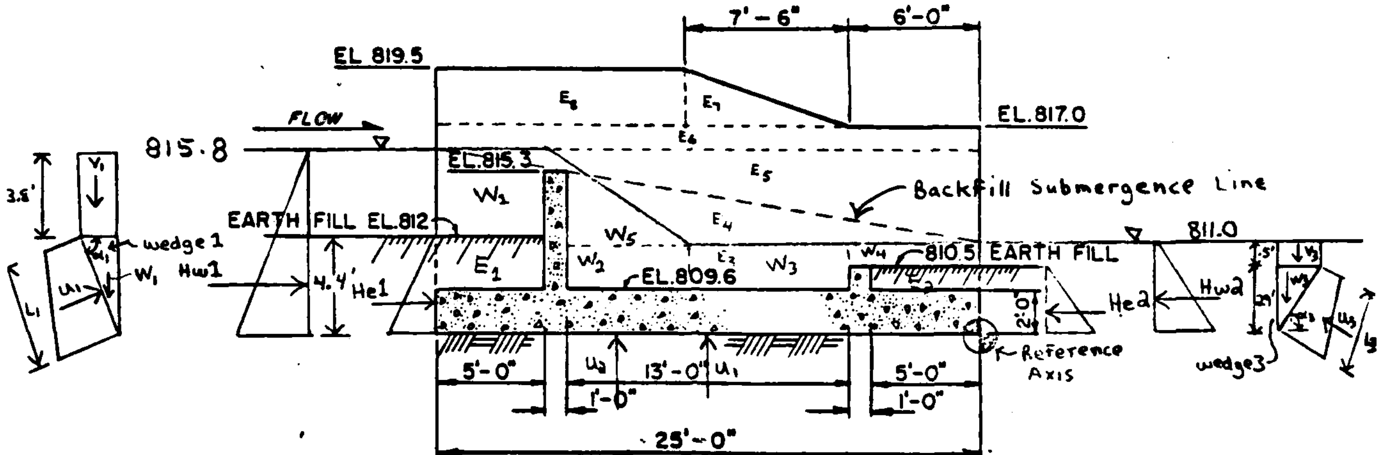
from Sec 1-1



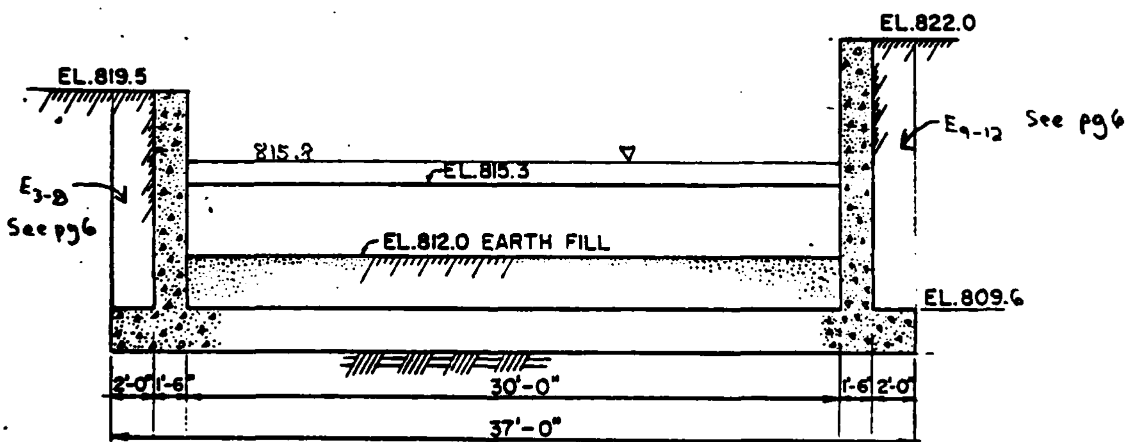
Sec. 4-4

NCS 14

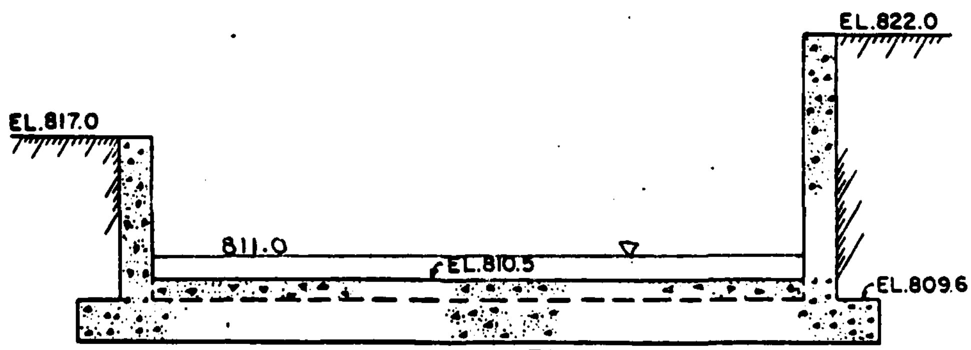
ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 8 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	



SECTION 1



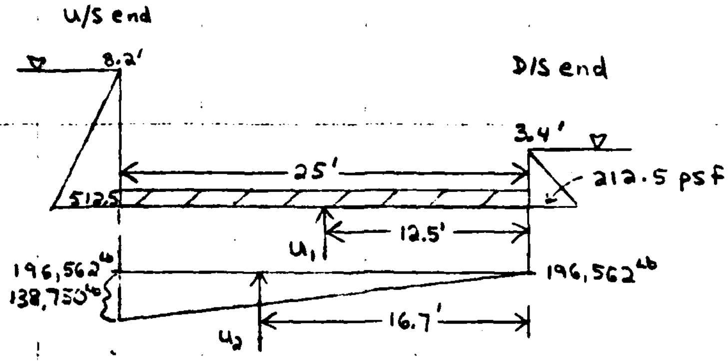
SECTION 2



SECTION 3

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 9 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	

- Find uplift forces:



Pressure at U/S end $= \gamma_w h = (62.5\ \text{lb/ft}^3)(8.2') = 512.5$ psf

" " D/S " $= (62.5)(3.4) = 212.5$ psf

bottom area of slab $= (25')(37') = 925\ \text{ft}^2$

$U_1 = (212.5\ \text{psf})(925\ \text{ft}^2) = 196,562\ \text{lb}$

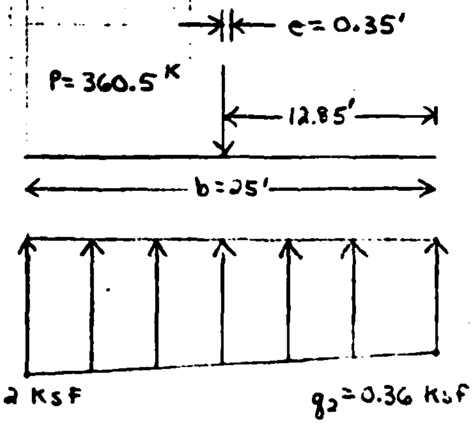
$U_2 = \frac{1}{2}(512.5 - 212.5\ \text{psf})(925\ \text{ft}^2) = 138,750\ \text{lb}$

- Find soil pressure for Case 2.

$$\text{arm} = \frac{\Sigma M}{\Sigma V} = \frac{9,588,722 - 4,955,138}{360,543} = 12.85\ \text{ft}$$ (within kern)

$$q_1 = \frac{P}{A}\left(1 + \frac{6e}{b}\right)$$

$$q_2 = \frac{P}{A}\left(1 - \frac{6e}{b}\right)$$



$$q_1 = \frac{360.5}{925\ \text{ft}^2}\left(1 + \frac{6(0.35')}{25'}\right) = 0.42\ \text{ksf}$$

$$q_2 = \frac{360.5}{925\ \text{ft}^2}\left(1 - \frac{6(0.35')}{25'}\right) = 0.36\ \text{ksf}$$

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Apr '82	PAGE 10 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	

– Case 3) Pool = 819.0 , T.W. = 815.9 , $\gamma_M = 120\ lb/ft^3$, $\gamma_{sat} = 125\ lb/ft^3$
$\phi = 30^\circ$, $\gamma_{sub} = 62.5\ lb/ft^3$, $\gamma_w = 62.5\ lb/ft^3$

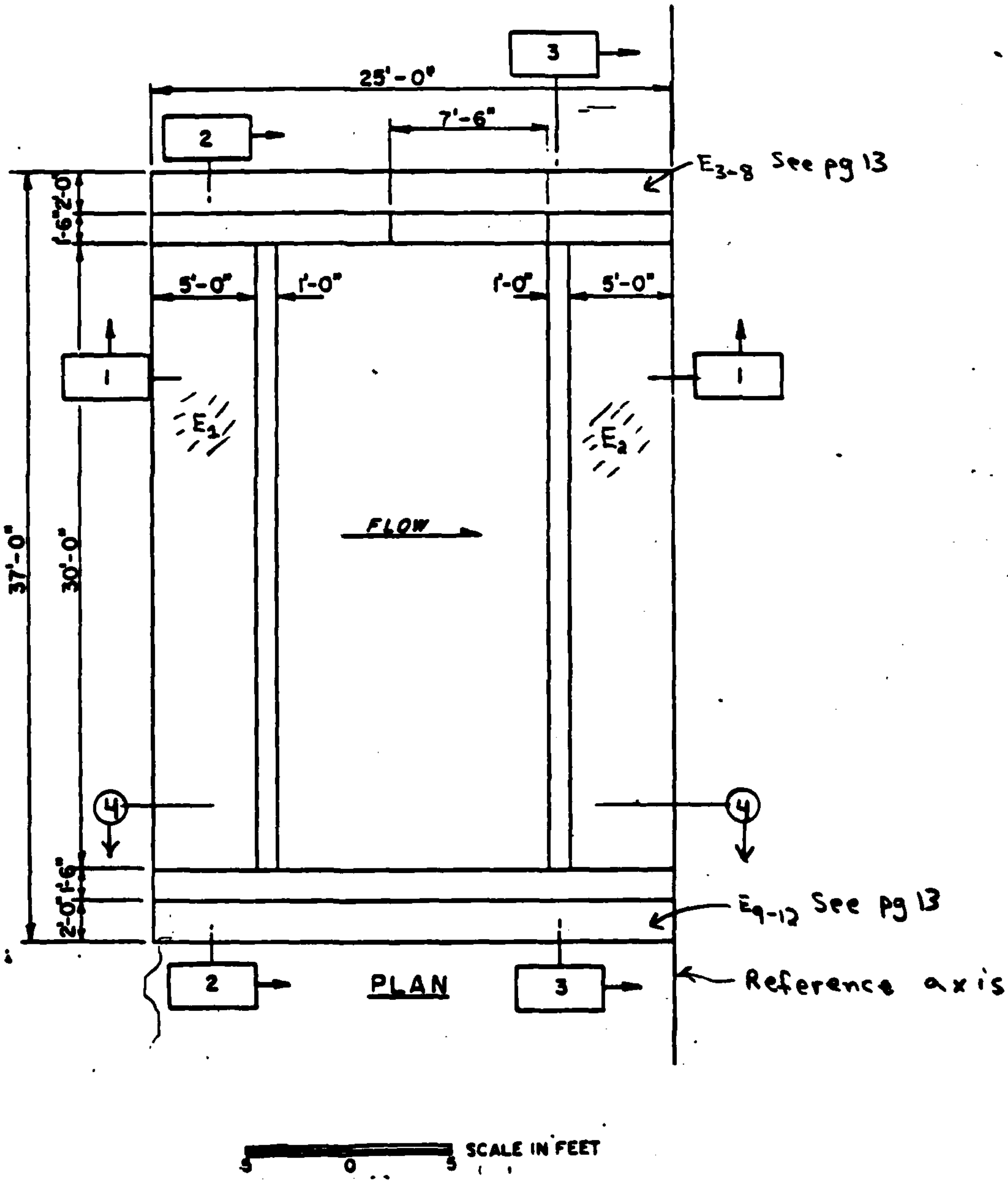
$He1 = \frac{\gamma_w H^2}{2} \cdot K_o L$

$Hw1 = \frac{1}{2}\gamma_w H^2 \cdot L$

Sym.	Factors	+↓ Forces (Lb)	+→	Arm (Ft.)	(+) Moment (Ft-Lb)	(–)
C	(See pg 1)	427,153		12.949	5,531,114	
E_1	(See pg 5)	22,500		22.5	506,250	
E_2	(See pg 5)	8,438		2.5	21,094	
E_3	2'(25')(6.3')(62.5 lb/ft³)	19,688		12.5	246,094	
E_4	½(25')(3.1')(2')(62.5)	4,844		2/3(25')	80,729	
E_5	½(11.5')(1.4')(2')(120 γ_m)	1,932		17.33	33,488	
E_6	2'(11.5')(0.5')(120 lb/ft³)	1,380		19.25	26,565	
E_7	½(2.5')(2.0')(7.5')(120)	2,250		11.0	24,750	
E_8	½(6')(1.1')(2')(120)	792		2.0	1,584	
E_9	2(25')(6.3')(62.5)	19,688		12.5	246,094	
E_{10}	½(2')(25')(3.1')(62.5)	4,844		2/3(25')	80,729	
E_{11}	½(2')(25')(3.1')(120)	9,300		1/3(25')	77,500	
E_{12}	2'(25')(3')(120 lb/ft³)	18,000		12.5	225,000	
W_1	30'(5')(9.4')(62.5 lb/ft³)	88,125		22.5	1,476,563	
W_2	(30')(6.3')(5.5')(62.5)	64,969		16.25	1,982,813	
W_3	½(6.5')(3.1')(30')(62.5)	18,891		17.83	336,883	
W_4	7.5'(6.3')(30')(62.5)	88,594		9.75	863,789	
W_5	6'(5.4')(30')(62.5)	60,750		3.0	182,250	
W_6	5(0.9)(30)(62.5)	8,438		2.5	21,094	
He1	(See pg 5)		9,075	1/3(4.4)		–13,612
He2	(See pg 5)		–3,942	1/3(2.9)	3,811	
Hw1	½(62.5 lb/ft³)(11.4')²(30')		121,838	1/3(11.4)		–462,983
Hw2	½(62.5 lb/ft³)(8.3')²(30')		–64,584	1/3(8.3)	178,683	
U_1	(See pg 14)	–479,844		12.5		–5,998,050
U_2	(See pg 14)	–89,609		2/3(25')		–1,493,490
		301,123	62,387		12,146,877	–7,968,135

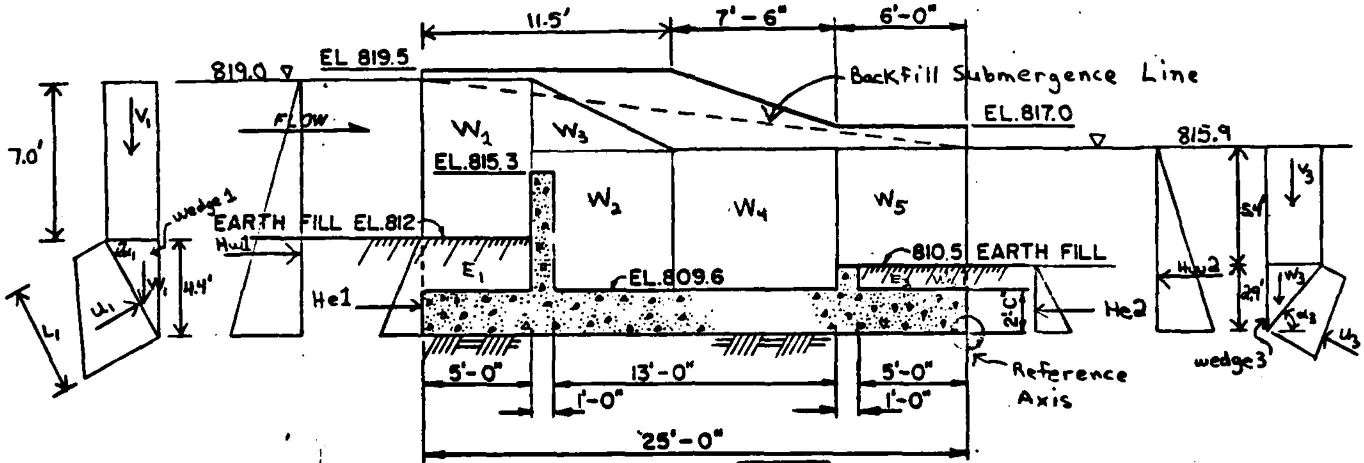
NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 68)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Apr '82	PAGE 11 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	

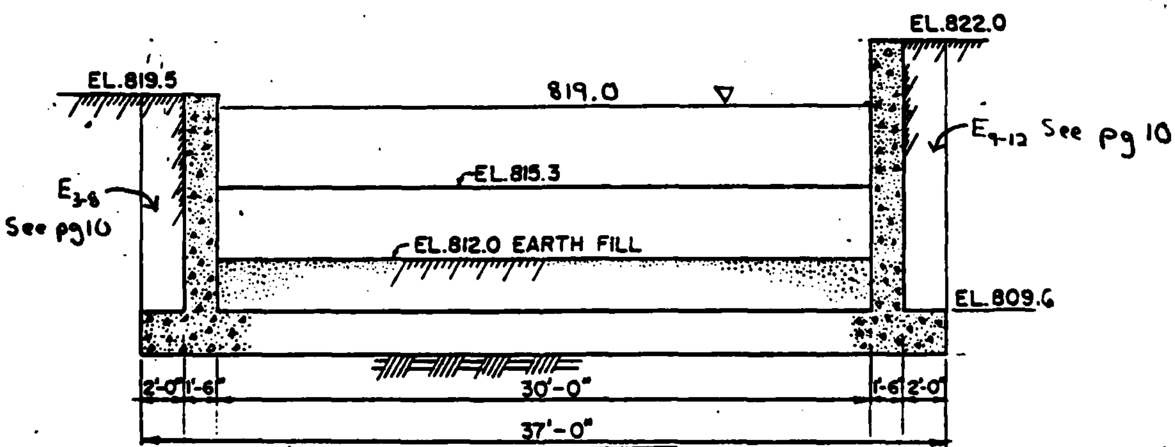


PLAN

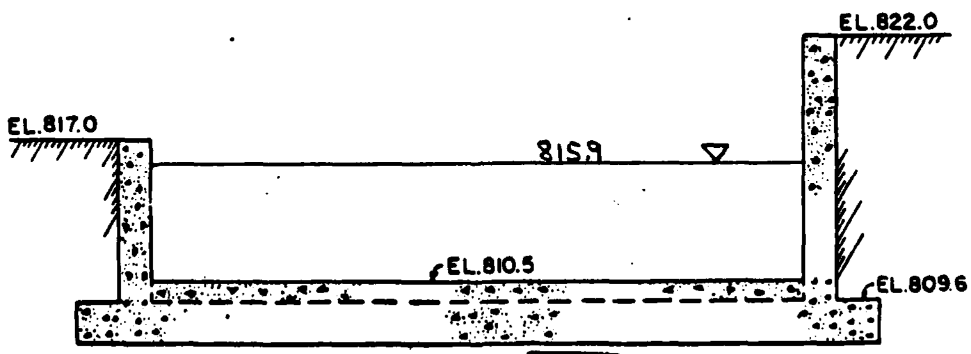
ST. PAUL DISTRICT COMPUTATION SHEET	DATE Apr '82	PAGE 12 OF 18	FILE NUMBER
NAME OF OFFICE		COMPUTATION Stability Analysis	
SUBJECT Bassett Creek		SOURCE DATA	
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	



SECTION 1



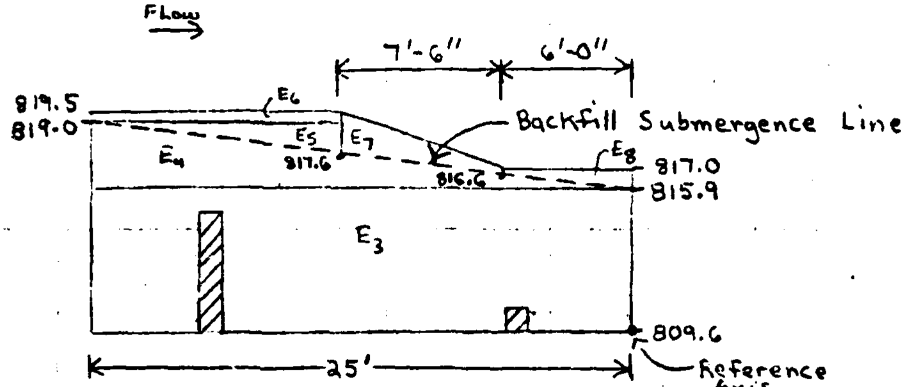
SECTION 2



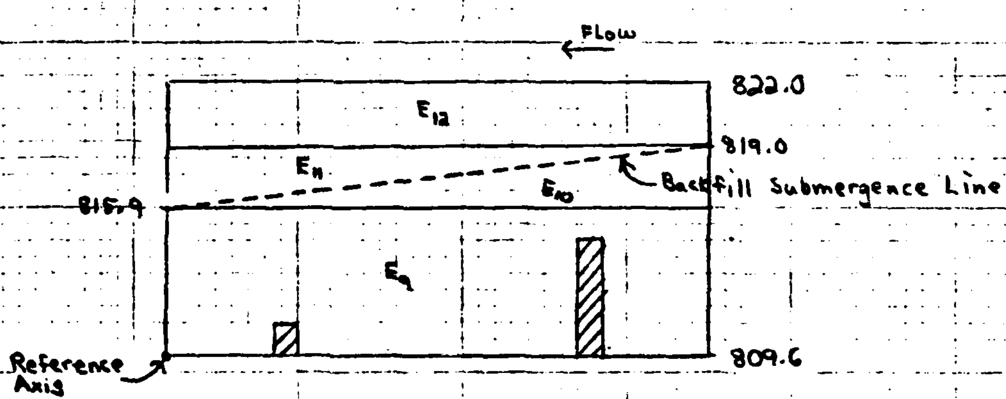
D-17

SECTION 3

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Apr '82	PAGE 13 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Stability Analysis		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	



from Sec 1-1



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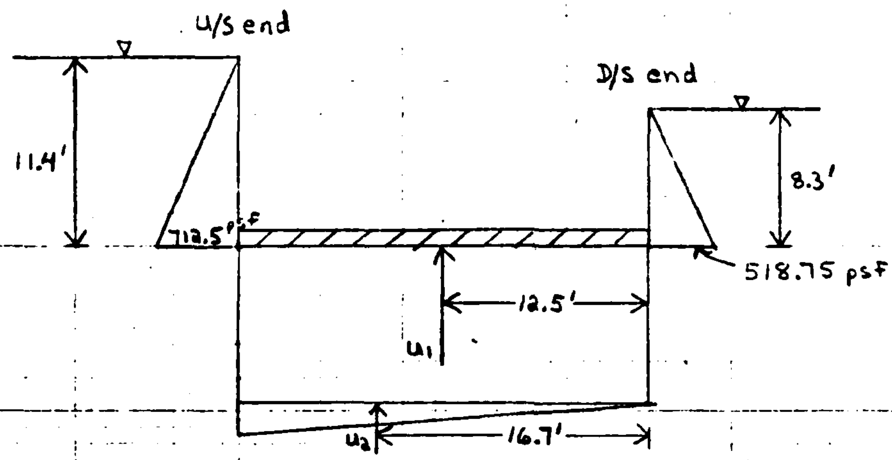
NCS 14
1 JUNE 73 (REPLACES NCO 14, 1 APR 63)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Apr '82	PAGE 14 OF 18	FILE NUMBER
NAME OF OFFICE		COMPUTATION Stability Analysis	
SUBJECT Bassett Creek		SOURCE DATA	
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	

- Find uplift forces:



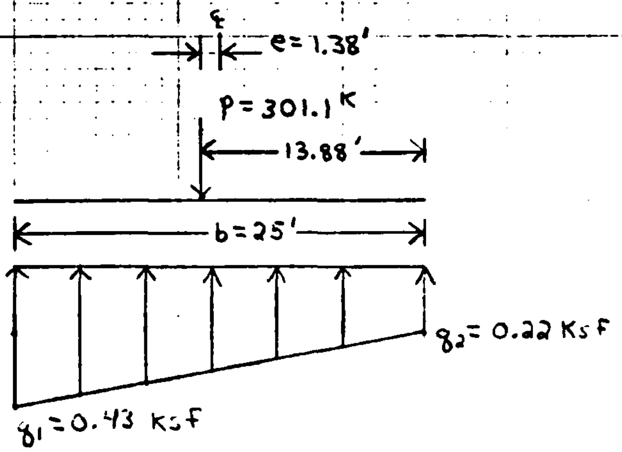
Pressure at U/S end = $\gamma_w h = (62.5\ ^{lb}/_{ft^3})(11.4\ ft) = 712.5$ psf
Pressure at D/S end = $(62.5\ ^{lb}/_{ft^3})(8.3\ ft) = 518.75$ psf

bottom area of slab = $25' \times 37' = 925\ ft^2$
$U_1 = (518.75\ psf)(925\ ft^2) = \underline{479{,}844\ lb}$
$U_2 = \frac{1}{2}(712.5 - 518.75\ psf)(925\ ft^2) = \underline{89{,}609\ lb}$

- Find soil pressure for Case 3

$$arm = \frac{\Sigma M}{\Sigma V} = \frac{12{,}146{,}877 - 7{,}968{,}135\ ft\text{-}lb}{301{,}123\ lb}$$

$= 13.88$ Ft (within kern)



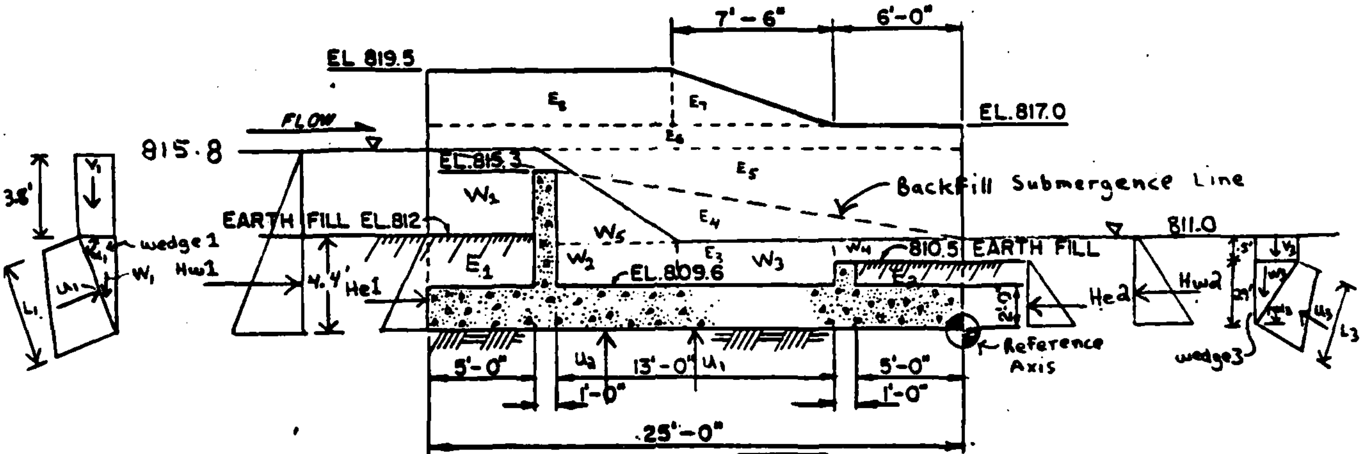
$$q_1 = \frac{P}{A}\left(1 + \frac{6e}{b}\right)$$
$$q_2 = \frac{P}{A}\left(1 - \frac{6e}{b}\right)$$

$$q_1 = \frac{301.1^K}{925\ ft^2}\left(1 + \frac{6(1.38')}{25'}\right) = 0.43\ \text{Ksf}$$

$$q_2 = \frac{301.1^K}{925\ ft^2}\left(1 - \frac{6(1.38')}{25'}\right) = 0.22\ \text{ksf}$$

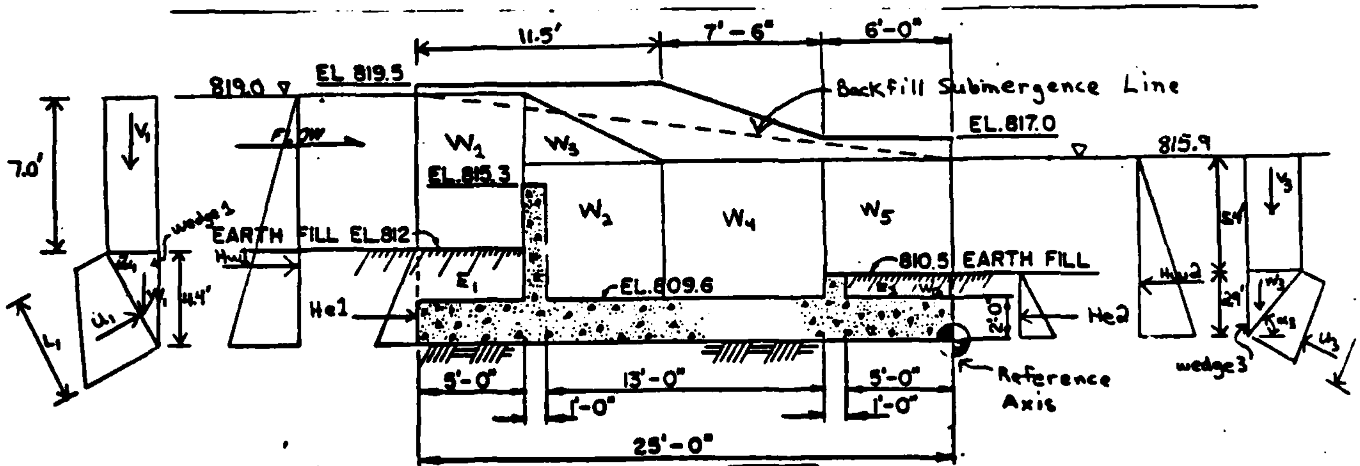
NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 63)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE Mar '82	PAGE 15 OF 18	FILE NUMBER
NAME OF OFFICE		COMPUTATION	
SUBJECT Bassett Creek		SOURCE DATA	
COMPUTED BY DMT	CHECKED BY GLC	APPROVED BY	



SECTION 1

Case 2



SECTION 1

Case 3

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 68)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 29 April 82	PAGE 16 OF 18	FILE NUMBER
NAME OF OFFICE		COMPUTATION Drop Structure Sliding Stability	
SUBJECT Bassett Creek Drop Structure		SOURCE DATA	
COMPUTED BY GLC, DMT	CHECKED BY GLC, DMT	APPROVED BY	

Case 2 Upper Pool 815.8 Tailwater 811.0

Try FS = 3.75

Wedge 1

$\phi_d = \text{Tan}^{-1}\left(\frac{\tan 30°}{FS}\right) =$ $\alpha_1 = -(45 + \frac{\phi d}{2}) = -49.38°$

$L_1 = 4.4/\sin\alpha_1 = 5.80'$

$V_1 = 3.8(62.5)(L_1)(\cos\alpha_1)(30) = 26893$
$W_1 = \frac{1}{2}(125)(4.4)(L_1)(\cos\alpha_1)(30) = 31,139$ } $V_1 + W_1 = 58032$

$U_1 = \left(\frac{3.8 + 8.2}{2}\right)(62.5)(L_1)(30) = 65217$

$P_0 - P_1 = -62856$

Wedge 2

$W_2 = 695855$

$U_2 = 335312$

$H_L = \frac{1}{2}(62.5)(3.8)^2 30 = 13538$

$H_R = \frac{1}{2}(62.5)(.5)^2 30 = 234$

$H_L - H_R = 13304$

$\alpha_2 = 0$

$P_1 - P_2 = 42,205$

Wedge 3

$\phi_d = \text{Tan}^{-1}\left(\frac{\tan 30°}{FS}\right) = 8.75°$ $\alpha_3 = 45 - \frac{\phi d}{2} = 40.62°$

$L_3 = 2.9/\sin\alpha_3 = 4.45$ $W_3 = \frac{1}{2}(125)(2.9)(L_3)(\cos\alpha_3)(30)$

$V_3 = .5(62.5)(L_3)(\cos\alpha_3)(30) = 3169$ $W_3 = 18382$

$W_3 + V_3 = 21552$

$U_3 = \left(\frac{.5 + 3.4}{2}\right)(62.5)(L_3)(30) = 16285$

$P_2 - P_3 = 21318$

$\sum P = -62856 + 42205 + 16285 = 667$

Try FS = 3.8

Wedge 1: $W_1 + V_1 = 58148$

$\alpha_1 = -49.32$ $L_1 = 5.80'$ $W_1 = 31201$

$V_1 = 26947$ $U_1 = 65273$ $P_0 - P_1 = -62909$

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 29 April 1982	PAGE 17 OF 18	FILE NUMBER
NAME OF OFFICE	COMPUTATION Sliding Stability		
SUBJECT Bassett Creek Drop Structure	SOURCE DATA		
COMPUTED BY G.L.C., DMT	CHECKED BY DMT, GLC	APPROVED BY	

Wedge 2

Forces same as FS = 3.75

$P_1 - P_2 = 41475$

Wedge 3

$\alpha_3 = 40.68°$ $L_3 = 4.45'$

$V_3 = 3163$ $W_3 = 18346$

$V_3 + W_3 = 21509$ $U_3 = 16266$

$P_2 - P_3 = 21275$

$\Sigma P = -62909 + 41475 + 21275 = -159$ $\therefore FS \approx 3.8$

Case 3 Pool 819.0 Tailwater 815.9

Try FS: 3.00

Wedge 1

$\alpha_1 = -50.45$ $L_1 = 4.4/\sin\alpha_1 = 5.71'$

$V_1 = 7(62.5)(L_1)(\cos\alpha_1)(30) = 47696$

$W_1 = \frac{1}{2}(125)(4.4)(L_1)(\cos\alpha_1)(30) = 29980$

$V_1 + W_1 = 77676$

$U_1 = \left(\frac{7+11.4}{2}\right)(62.5)(L_1)(30) = 98439$

$P_0 - P_1 = -88280$

Wedge 2

$W_2 = 870576$ $H_L = \frac{1}{2}(62.5)(7)^2(30) = 45938$

$U_2 = 569453$ $H_R = \frac{1}{2}(62.5)(7)^2(30) = 27338$

$H_L - H_R = 18,600$ $\alpha_2 = 0$

$P_1 - P_2 = 39351$

Wedge 3

$\phi_d = 10.89°$ $\alpha_3 = 45 - \frac{\phi_d}{2} = 39.55°$

$L_3 = 2.9/\sin\alpha_3 = 4.55'$

$V_3 = 5.4(62.5)(L_3)(\cos\alpha_3)(30) = 35552$

$W_3 = \frac{1}{2}(125)(2.9)(L_3)(\cos\alpha_3)(30) = 19093$

$\Big\}\ V_3 + W_3 = 54645$

$U_3 = \left(\frac{5.4 + 8.3}{2}\right)62.5(L_3)(30) = 58491$

$P_2 - P_3 = 48806$

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 63)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 29 April 82	PAGE 18 OF 18	FILE NUMBER
NAME OF OFFICE		COMPUTATION Sliding Stability	
SUBJECT Bassett Creek Drop Structure		SOURCE DATA	
COMPUTED BY GLC, DMT	CHECKED BY DMT, GLC	APPROVED BY	

$\Sigma P = -88280 + 39351 + 48806 = -123$

$\therefore F.S. = 3.00$

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 63)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 11/20/80	PAGE 1 OF 10	FILE NUMBER
NAME OF OFFICE	COMPUTATION Sheet Pile Wall		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY G.L.C.	CHECKED BY	APPROVED BY	

F.S. = 1.0 Retaining Wall at Bridge - Left Bank

Loading Case	Penetration (ft.)	Bottom Elevation	Maximum Moment	Deflection Scaled	Deflection Actual (in)
Normal Water	9.31	799.69	10937	1.76E 9	.33
Normal Water with RR	12.32	796.68	23781	5.31E 9	.99
Design Water Surface	8.09	800.91	7820	1.09E 9	.20
DWS with RR	11.31	797.69	19161	3.85E 9	.72

$S_{req'd} = \frac{23781(12)}{.6(33000)} = 14.41 \text{ in}^3$

Use PZ-27 $S_x = 30.2 \text{ in}^3$ $I = 184.2 \text{ in}^4/\text{ft}$ of wall

Actual Deflection = $\frac{\text{Scaled Deflection}}{29\times10^6(184.2)}$

Increase penetration by 20%

∴ 1.2(12.32) = 14.78' Elevation = 794.22 use 794.0

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PROGRAM SHTWAL - DESIGN/ANALYSIS OF ANCHORED
OR CANTILEVER SHEET PILE WALLS BY CLASSICAL METHODS
DATE: 11/20/81                         TIME: 13:28:40

1. INPUT DATA

1.A.--HEADING

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
NORMAL WATER CASE WITH RAILROAD LOAD

1.B.--WALL TYPE, MODE, METHOD
    CANTILEVER WALL DESIGN

1.C.--WALL DESCRIPTION
    TOP OF WALL ELEVATION =  818.00 (FT)
    FACTOR OF SAFETY      =    1.00

1.D.--RIGHT SIDE SOIL DESCRIPTION
    NUMBER OF RIGHT SIDE SURFACE POINTS =  1
    NUMBER OF RIGHT SIDE SOIL LAYERS    =  1

    RIGHT SIDE SURFACE POINT COORDINATES
    POINT      ELEVATION      X-COORD
     NO.         (FT)          (FT)
      1         818.00         0.00

RIGHT SIDE SOIL LAYER DATA
                INTERNAL                  WALL      BOTTOM
LAYER    UNIT   FRICTION                FRICTION     ELEV       BOTTOM
 NO.   WEIGHT    ANGLE     COHESION      ANGLE     AT WALL      SLOPE
        (PCF)    (DEG)      (PSF)        (DEG)      (FT)       (FT/FT)
  1    120.00    28.00       0.00        18.60

1.E.--LEFT SIDE SOIL DESCRIPTION
    NUMBER OF LEFT SIDE SURFACE POINTS    =  1
    NUMBER OF LEFT SIDE SOIL LAYERS       =  1

    LEFT SIDE SURFACE POINT COORDINATES
    POINT      ELEVATION      X-COORD
     NO.         (FT)          (FT)
      1         800.00         0.00

LEFT  SIDE SOIL LAYER DATA
                INTERNAL                  WALL      BOTTOM
LAYER    UNIT   FRICTION                FRICTION     ELEV       BOTTOM
 NO.   WEIGHT    ANGLE     COHESION      ANGLE     AT WALL      SLOPE
        (PCF)    (DEG)      (PSF)        (DEG)      (FT)       (FT/FT)
  1    120.00    28.00       0.00        18.60

1.F.--WATER DATA
    RIGHT SIDE ELEVATION        =  808.50 (FT)
    LEFT SIDE ELEVATION         =  808.50 (FT)
    WATER UNIT WEIGHT           =   62.40 (PCF)
    SEEPAGE GRADIENT            =    0.00 (FT/FT)

1.G.--SURCHARGE LOADS
    NUMBER OF LINE LOADS             =  0
    DISTRIBUTED LOAD DISTRIBUTION = STRIP

    STRIP SURCHARGE LOAD
    DISTANCE FROM WALL =    10.00 FT
    WIDTH              =     5.00 FT
    LOAD               =  2084.00 PSF

1.H.--HORIZONTAL LOADS
    NUMBER OF HORIZONTAL LINE LOADS        =    0
    NUMBER OF HORIZONTAL PRESSURE POINTS   =    0
    EARTHQUAKE ACCELERATION                =    0.00 (G'S)


DO YOU WANT A PLOT OF INPUT GEOMETRY?
ENTER 'YES' OR 'NO'
1>
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PROGRAM SHTWAL - DESIGN/ANALYSIS OF ANCHORED
OR CANTILEVER SHEET PILE WALLS BY CLASSICAL METHODS
DATE: 11/20/81                          TIME: 13:25:29

2. RESULTS

2.A.--HEADING

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
NORMAL WATER CASE WITH RAILROAD LOAD


2.B.--SUMMARY OF RESULTS FOR CANTILEVER WALL DESIGN


     SOIL PRESSURES DETERMINED BY COULOMB
     COEFFICIENTS AND THEORY OF ELASTICITY
     EQUATIONS FOR SURCHARGE LOADS


     WALL BOTTOM:
          PENETRATION :     12.32 (FT)
          ELEVATION   :    795.68 (FT)

     BENDING MOMENT:
          MAXIMUM     :   -23781. (LB-FT)
          ELEVATION   :     802.6 (FT)

     SCALED DEFLECTION:
          MAXIMUM     :  5.31E+09 (LB-IN3)
          ELEVATION   :     818.0 (FT)

          (NOTE: DIVIDE SCALED DEFLECTION BY MODULUS
          OF ELASTICITY IN PSI TIMES PILE MOMENT OF
          INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES)


DO YOU WANT COMPLETE RESULTS OUTPUT?
ENTER 'YES' OR 'NO'
1>
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3/10

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PROGRAM SHTWAL - DESIGN/ANALYSIS OF ANCHORED
OR CANTILEVER SHEET PILE WALLS BY CLASSICAL METHODS
DATE: 11/20/81                          TIME: 13:34:13

1. INPUT DATA

1.A.--HEADING

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
DESIGN WATER CASE WITH RAILROAD LOAD

1.B.--WALL TYPE, MODE, METHOD
     CANTILEVER WALL DESIGN

1.C.--WALL DESCRIPTION
     TOP OF WALL ELEVATION =  818.00 (FT)
     FACTOR OF SAFETY      =    1.00

1.D.--RIGHT SIDE SOIL DESCRIPTION
     NUMBER OF RIGHT SIDE SURFACE POINTS =  1
     NUMBER OF RIGHT SIDE SOIL LAYERS    =  1

     RIGHT SIDE SURFACE POINT COORDINATES
     POINT       ELEVATION       X-COORD
      NO.           (FT)           (FT)
       1          818.00           0.00

RIGHT SIDE SOIL LAYER DATA
                INTERNAL                   WALL     BOTTOM
LAYER    UNIT   FRICTION                 FRICTION    ELEV       BOTTOM
 NO.    WEIGHT   ANGLE      COHESION      ANGLE     AT WALL      SLOPE
         (PCF)   (DEG)        (PSF)       (DEG)       (FT)      (FT/FT)
  1     120.00   28.00        0.00       18.60

1.E.--LEFT SIDE SOIL DESCRIPTION
     NUMBER OF LEFT SIDE SURFACE POINTS    =  1
     NUMBER OF LEFT SIDE SOIL LAYERS       =  1

     LEFT SIDE SURFACE POINT COORDINATES
     POINT       ELEVATION       X-COORD
      NO.           (FT)           (FT)
       1          809.00           0.00

LEFT  SIDE SOIL LAYER DATA
                INTERNAL                   WALL     BOTTOM
LAYER    UNIT   FRICTION                 FRICTION    ELEV       BOTTOM
 NO.    WEIGHT   ANGLE      COHESION      ANGLE     AT WALL      SLOPE
         (PCF)   (DEG)        (PSF)       (DEG)       (FT)      (FT/FT)
  1     120.00   28.00        0.00       18.60

1.F.--WATER DATA
     RIGHT SIDE ELEVATION         =  814.00 (FT)
     LEFT SIDE ELEVATION          =  814.00 (FT)
     WATER UNIT WEIGHT            =   62.40 (PCF)
     SEEPAGE GRADIENT             =    0.00 (FT/FT)

1.G.--SURCHARGE LOADS
     NUMBER OF LINE LOADS            = 0
     DISTRIBUTED LOAD DISTRIBUTION = STRIP

     STRIP SURCHARGE LOAD
     DISTANCE FROM WALL =    10.00 FT
     WIDTH              =     5.00 FT
     LOAD               = 2084.00 PSF

1.H.--HORIZONTAL LOADS
     NUMBER OF HORIZONTAL LINE LOADS         =    0
     NUMBER OF HORIZONTAL PRESSURE POINTS    =    0
     EARTHQUAKE ACCELERATION                 =    0.00 (G'S)


DO YOU WANT A PLOT OF INPUT GEOMETRY?
ENTER 'YES' OR 'NO'
I)
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4/10

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PROGRAM SHTWAL - DESIGN/ANALYSIS OF ANCHORED
OR CANTILEVER SHEET PILE WALLS BY CLASSICAL METHODS
DATE: 11/30/81                      TIME: 13:35:04

2. RESULTS

2.A.--HEADING

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
DESIGN WATER CASE WITH RAILROAD LOAD

2.B.--SUMMARY OF RESULTS FOR CANTILEVER WALL DESIGN

     SOIL PRESSURES DETERMINED BY COULOMB
     COEFFICIENTS AND THEORY OF ELASTICITY
     EQUATIONS FOR SURCHARGE LOADS

     WALL BOTTOM:
          PENETRATION :     11.31 (FT)
          ELEVATION   :    797.69 (FT)

     BENDING MOMENT:
          MAXIMUM     :   -19161. (LB-FT)
          ELEVATION   :     803.3 (FT)

     SCALED DEFLECTION:
          MAXIMUM     :  3.85E+08 (LB-IN3)
          ELEVATION   :     818.0 (FT)

          (NOTE: DIVIDE SCALED DEFLECTION BY MODULUS
          OF ELASTICITY IN PSI TIMES PILE MOMENT OF
          INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES)

DO YOU WANT COMPLETE RESULTS OUTPUT?
ENTER 'YES' OR 'NO'
I>
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5/10

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PROGRAM SHTWAL - DESIGN/ANALYSIS OF ANCHORED
OR CANTILEVER SHEET PILE WALLS BY CLASSICAL METHODS
DATE: 11/20/81                              TIME: 13:30:24

1. INPUT DATA

1.A.--HEADING

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
NORMAL WATER CASE WITHOUT RAILROAD LOAD


1.B.--WALL TYPE, MODE, METHOD
     CANTILEVER WALL DESIGN


1.C.--WALL DESCRIPTION
     TOP OF WALL ELEVATION :  818.00 (FT)
     FACTOR OF SAFETY      :    1.00


1.D.--RIGHT SIDE SOIL DESCRIPTION
     NUMBER OF RIGHT SIDE SURFACE POINTS :  1
     NUMBER OF RIGHT SIDE SOIL LAYERS    :  1

     RIGHT SIDE SURFACE POINT COORDINATES
     POINT      ELEVATION      X-COORD
      NO.         (FT)          (FT)
       1         818.00         0.00

RIGHT SIDE SOIL LAYER DATA
                  INTERNAL                 WALL     BOTTOM
LAYER    UNIT     FRICTION                FRICTION   ELEV     BOTTOM
 NO.    WEIGHT     ANGLE     COHESION      ANGLE    AT WALL    SLOPE
         (PCF)     (DEG)      (PSF)        (DEG)     (FT)     (FT/FT)
  1     120.00     28.00      0.00         18.50

1.E.--LEFT SIDE SOIL DESCRIPTION
     NUMBER OF LEFT SIDE SURFACE POINTS    :  1
     NUMBER OF LEFT SIDE SOIL LAYERS       :  1


     LEFT SIDE SURFACE POINT COORDINATES
     POINT      ELEVATION      X-COORD
      NO.         (FT)          (FT)
       1         800.00         0.00

LEFT  SIDE SOIL LAYER DATA
                  INTERNAL                 WALL     BOTTOM
LAYER    UNIT     FRICTION                FRICTION   ELEV     BOTTOM
 NO.    WEIGHT     ANGLE     COHESION      ANGLE    AT WALL    SLOPE
         (PCF)     (DEG)      (PSF)        (DEG)     (FT)     (FT/FT)
  1     120.00     28.00      0.00         18.50

1.F.--WATER DATA
     RIGHT SIDE ELEVATION          :  809.50 (FT)
     LEFT SIDE ELEVATION           :  809.50 (FT)
     WATER UNIT WEIGHT             :   62.40 (PCF)
     SEEPAGE GRADIENT              :    0.00 (FT/FT)

1.G.--SURCHARGE LOADS
     NUMBER OF LINE LOADS            :  0
     DISTRIBUTED LOAD DISTRIBUTION : NONE

1.H.--HORIZONTAL LOADS
     NUMBER OF HORIZONTAL LINE LOADS         :    0
     NUMBER OF HORIZONTAL PRESSURE POINTS    :    0
     EARTHQUAKE ACCELERATION                 :    0.00 (G'S)


DO YOU WANT A PLOT OF INPUT GEOMETRY?
ENTER 'YES' OR 'NO'
1>
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6/13

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PROGRAM SHTWAL - DESIGN/ANALYSIS OF ANCHORED
OR CANTILEVER SHEET PILE WALLS BY CLASSICAL METHODS
DATE: 11/20/81                          TIME: 13:31:08

8. RESULTS

8.A.--HEADING

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
NORMAL WATER CASE WITHOUT RAILROAD LOAD


8.B.--SUMMARY OF RESULTS FOR CANTILEVER WALL DESIGN


     SOIL PRESSURES DETERMINED BY COULOMB
     COEFFICIENTS AND THEORY OF ELASTICITY
     EQUATIONS FOR SURCHARGE LOADS


     WALL BOTTOM:
          PENETRATION :      9.31 (FT)
          ELEVATION   :    798.69 (FT)

     BENDING MOMENT:
          MAXIMUM     :   -10937. (LB-FT)
          ELEVATION   :     804.2 (FT)

     SCALED DEFLECTION:
          MAXIMUM     :  1.76E+09 (LB-IN3)
          ELEVATION   :     818.0 (FT)


          (NOTE: DIVIDE SCALED DEFLECTION BY MODULUS
          OF ELASTICITY IN PSI TIMES PILE MOMENT OF
          INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES)


 DO YOU WANT COMPLETE RESULTS OUTPUT?
 ENTER 'YES' OR 'NO'
I>
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D-30

7/

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PROGRAM SHTWAL - DESIGN/ANALYSIS OF ANCHORED
OR CANTILEVER SHEET PILE WALLS BY CLASSICAL METHODS
DATE: 11/20/81                              TIME: 13:35:58

1. INPUT DATA

1.A.--HEADING

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
DESIGN WATER CASE WITHOUT RAILROAD LOAD

1.B.--WALL TYPE, MODE, METHOD
     CANTILEVER WALL DESIGN

1.C.--WALL DESCRIPTION
     TOP OF WALL ELEVATION :  818.00 (FT)
     FACTOR OF SAFETY      :    1.00

1.D.--RIGHT SIDE SOIL DESCRIPTION
     NUMBER OF RIGHT SIDE SURFACE POINTS :  1
     NUMBER OF RIGHT SIDE SOIL LAYERS    :  1

     RIGHT SIDE SURFACE POINT COORDINATES
     POINT        ELEVATION       X-COORD
      NO.           (FT)           (FT)
       1           818.00          0.00

RIGHT SIDE SOIL LAYER DATA
                   INTERNAL                  WALL     BOTTOM
LAYER     UNIT     FRICTION                FRICTION    ELEV       BOTTOM
 NO.     WEIGHT     ANGLE      COHESION     ANGLE     AT WALL      SLOPE
         (PCF)      (DEG)       (PSF)       (DEG)      (FT)       (FT/FT)
  1     120.00      28.00       0.00        18.60

1.E.--LEFT SIDE SOIL DESCRIPTION
     NUMBER OF LEFT SIDE SURFACE POINTS    :  1
     NUMBER OF LEFT SIDE SOIL LAYERS       :  1

     LEFT SIDE SURFACE POINT COORDINATES
     POINT        ELEVATION       X-COORD
      NO.           (FT)           (FT)
       1           800.00          0.00

LEFT  SIDE SOIL LAYER DATA
                   INTERNAL                  WALL     BOTTOM
LAYER     UNIT     FRICTION                FRICTION    ELEV       BOTTOM
 NO.     WEIGHT     ANGLE      COHESION     ANGLE     AT WALL      SLOPE
         (PCF)      (DEG)       (PSF)       (DEG)      (FT)       (FT/FT)
  1     120.00      28.00       0.00        18.60

1.F.--WATER DATA
     RIGHT SIDE ELEVATION       :  814.80 (FT)
     LEFT SIDE ELEVATION        :  814.80 (FT)
     WATER UNIT WEIGHT          :   62.40 (PCF)
     SEEPAGE GRADIENT           :    0.00 (FT/FT)

1.G.--SURCHARGE LOADS
     NUMBER OF LINE LOADS            :  0
     DISTRIBUTED LOAD DISTRIBUTION : NONE

1.H.--HORIZONTAL LOADS
     NUMBER OF HORIZONTAL LINE LOADS        :   0
     NUMBER OF HORIZONTAL PRESSURE POINTS   :   0
     EARTHQUAKE ACCELERATION                :   0.00 (G'S)

DO YOU WANT A PLOT OF INPUT GEOMETRY?
ENTER 'YES' OR 'NO'
I>
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D-31

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PROGRAM SHTWAL - DESIGN/ANALYSIS OF ANCHORED
OR CANTILEVER SHEET PILE WALLS BY CLASSICAL METHODS
DATE: 11/20/81                            TIME: 13:36:44

2. RESULTS

2.A.--HEADING

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
DESIGN WATER CASE WITHOUT RAILROAD LOAD

2.B.--SUMMARY OF RESULTS FOR CANTILEVER WALL DESIGN

    SOIL PRESSURES DETERMINED BY COULOMB
    COEFFICIENTS AND THEORY OF ELASTICITY
    EQUATIONS FOR SURCHARGE LOADS

    WALL BOTTOM:
        PENETRATION :      8.09 (FT)
        ELEVATION   :    800.91 (FT)

    BENDING MOMENT:
        MAXIMUM     :    -7820. (LB-FT)
        ELEVATION   :     805.1 (FT)

    SCALED DEFLECTION:
        MAXIMUM     :  1.09E+09 (LB-IN3)
        ELEVATION   :     818.0 (FT)

        (NOTE: DIVIDE SCALED DEFLECTION BY MODULUS
        OF ELASTICITY IN PSI TIMES PILE MOMENT OF
        INERTIA IN IN**4 TO OBTAIN DEFLECTION IN INCHES)

DO YOU WANT COMPLETE RESULTS OUTPUT?
ENTER 'YES' OR 'NO'
1>
```

D-32

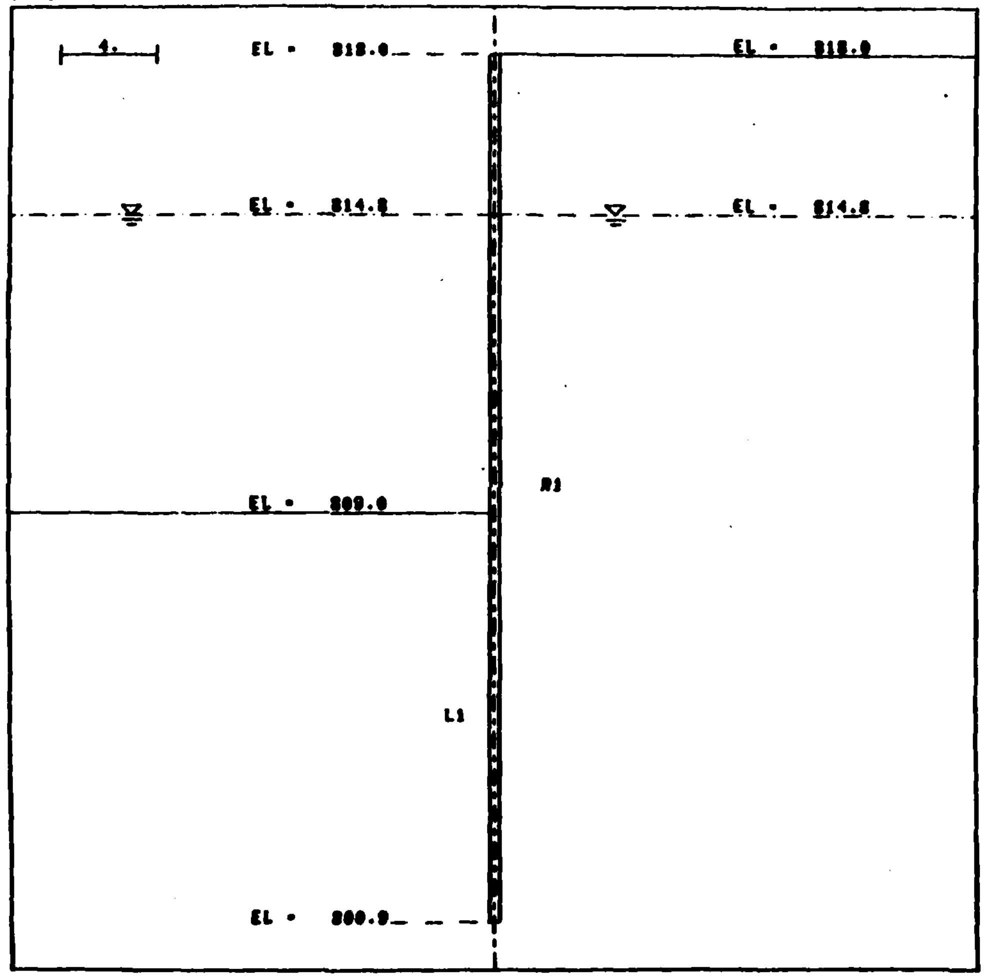
LEFTSIDE SOIL PROPERTIES

LAYER	C	PHI	GAMMA	DELTA
L1	0.	28.0	120.0	18.6

RIGHTSIDE SOIL PROPERTIES

LAYER	C	PHI	GAMMA	DELTA
R1	0.	28.0	120.0	18.6

BASSETT CREEK WINGWALL AT BRIDGE LEFT SIDE
DESIGN WATER CASE WITHOUT RAILROAD LOAD

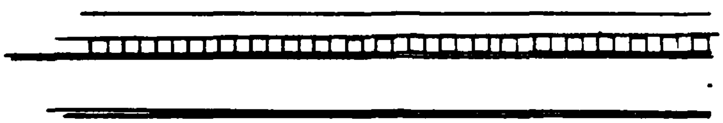


10/10

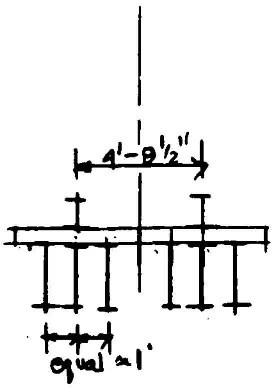
ST. PAUL DISTRICT COMPUTATION SHEET	DATE 11 August 1981	PAGE 1 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION Fruen Mill R.R. Bridge		
SUBJECT Bassett Creek	SOURCE DATA AREA Section 15-1		
COMPUTED BY GLC	CHECKED BY	APPROVED BY	

Clear span = 67'
Due to skew, use 76' for span length
with 2 spans, and 4' pier, then each span is $\frac{76-4}{2} = 36'$

$M_{max\,LL} = 1097.3\ '^{K}$ $\quad V_{max} = 141.12^{K}$
from AREA pg 15-1-35



∴ 2' max depth of beam



$$M = \frac{1097.3\,(12)}{3}$$
$$M = 4389.20''^{K}$$
(1.3.4.1(c))

for $F_b = 20$ ksi $\quad S_x = \frac{4389.20''^{K}}{20\ \text{ksi}} = 219.5\ in^3$

Member	S_x	Depth
W21X111	273	21.51"
~~W24X94~~	~~222~~	~~24.31~~
W24X104	258	24.06
W24X117	291	24.26 D-34

Add DL moment
$$M = \frac{1.15(36)^2(12)}{8} = 223.56^{1K}$$
$M_{Total} = 4612.76 \quad S_x = 231\ in^3$

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 11 August 1981	PAGE 2 OF 33	FILE NUMBER
NAME OF OFFICE		COMPUTATION Fruen Mill R.R. Bridge	
SUBJECT Bassett Creek		SOURCE DATA	
COMPUTED BY GLC	CHECKED BY	APPROVED BY	

Determine Allowable for W21X111 (use lower depth to provide more flexibility and clearance)

$r_T = 3.28$ $d/A_f = 1.99$ $I_x = 2670$ $I_y = 274$

$r_x = 9.05$ $r_y = 2.90$

$F_b = 20000 - 0.4(l/r_T)^2 = 20000 - .4\left(\frac{36 \times 12}{3.28}\right)^2$

$F_b = 13061$ psi ← Governs

$F_b = \frac{10.5 \times 10^6}{l\left(\frac{d}{A_f}\right)} = \frac{10.5 \times 10^6}{36(12)(1.99)} = 12214$ psi

$f_b = \frac{4612.76}{273} = 16.90$ ksi overstressed

S_x req'd $= \frac{4612.76}{13} = 355$ in^3

There is no 21" deep member with sufficent section modulus ∴ try 24" deep member

Try W24 X 146 $d = 24.74$ $r_T = 3.43$ $d/A_f = 1.76$ $S_x = 371$

$F_b = 20000 - .4\left(\frac{36 \times 12}{3.43}\right)^2 = 13655$ psi

$F_b = \frac{10.5 \times 10^6}{36(12)(1.76)} = 13810$ psi ← Governs

$W_{DL} = 146 + \underset{\text{rail}}{\frac{200}{3}} = 212.67$ $M_{DL} = \frac{.212(36)^2}{8} 12 = 413.42$"K

$M_{Total} = 4389.20 + 413.42 = 4802.62$"K

$f_b = \frac{4802.62}{371} = 12.95$ ksi OK

Check shear

$V = \frac{142.12}{3} + .212\left(\frac{36}{2}\right) = 51.2^k$

$f_v = \frac{V}{A_w} = \frac{51.2}{(24.74 - 2 * 1.090).65} = 3.5$ ksi < 20ksi OK

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3

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 68)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 11 August 1981	PAGE 3 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION Fruen Mill R.R. Bridge		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY GLC	CHECKED BY	APPROVED BY	

Check $\frac{l}{r_{min}} = \frac{36(12)}{3.01} = 143.5 = 1.5.1$

$\frac{l}{r_T} \leq 157 \quad \frac{36(12)}{3.43} = 126 \leq 157$

$\therefore$ 1.7.1(6) satisfied

Check use X0045

ASSOCIATION OF AMERICAN RAILROADS TECHNICAL CENTER
CHICAGO, ILLINOIS
REVISED DEC.1975

M N & S BRIDGE OVER BASSETT CREEK AT FRUEN MILL

GIRDER ANALYSIS

DECK PLATE GIRDER 36.00 FT SPAN

C-C GIRDERS 4.71 .167 AXLE LOAD TO EACH GIRDER

UNIFORM DEAD LOAD .213 KIPS/FT

DIESEL LOCOMOTIVE

UNBALLASTED DECK
1969 AREA SPECIFICATIONS

LOADING E 80.0

SECTION PROPERTIES

SECTION 1 TYPE 5 0.00 FT FROM LEFT SUPPORT

ROLLED SECTION
AREA 43.000 CENTROID 12.370 MOM INERTIA 4580.00

OPEN HOLES
TOP FLANGE 0.0 0.000 IN. O.H.
BOT FLANGE 0.0 0.000 IN. O.H.
WEB 0.0 O.H.
SIZE 0.000
SPACE 0.000

CENTROID 12.370

GROSS MOMENT OF INERTIA 4580.00 SECTION MODULUS 370.25
NET MOMENT OF INERTIA 4580.00 SECTION MODULUS 370.25

RADIUS OF GYRATION OF COMP AREA ABOUT WEAK AXIS 3.02

SECTION 2 TYPE 5 9.00 FT FROM LEFT SUPPORT

ROLLED SECTION
AREA 43.000 CENTROID 12.370 MOM INERTIA 4580.00

OPEN HOLES
TOP FLANGE 0.0 0.000 IN. O.H.
BOT FLANGE 0.0 0.000 IN. O.H.
WEB 0.0 O.H.
SIZE 0.000
SPACE 0.000

CENTROID 12.370

GROSS MOMENT OF INERTIA 4580.00 SECTION MODULUS 370.25
NET MOMENT OF INERTIA 4580.00 SECTION MODULUS 370.25

RADIUS OF GYRATION OF COMP AREA ABOUT WEAK AXIS 3.02

SECTION 3 TYPE 5 18.00 FT FROM LEFT SUPPORT

ROLLED SECTION
AREA 43.000 CENTROID 12.370 MOM INERTIA 4580.00

OPEN HOLES
TOP FLANGE 0.0 0.000 IN. O.H.
BOT FLANGE 0.0 0.000 IN. O.H.
WEB 0.0 O.H.
SIZE 0.000
SPACE 0.000

CENTROID 12.370

GROSS MOMENT OF INERTIA 4580.00 SECTION MODULUS 370.25
NET MOMENT OF INERTIA 4580.00 SECTION MODULUS 370.25

RADIUS OF GYRATION OF COMP AREA ABOUT WEAK AXIS 3.02

SECTION 4 TYPE 5 27.00 FT FROM LEFT SUPPORT

ROLLED SECTION
AREA 43.000 CENTROID 12.370 MOM INERTIA 4580.00

OPEN HOLES
TOP FLANGE 0.0 0.000 IN. O.H.

```
    BOT FLANGE  0.0    0.000 IN. O.H.
    WEB  0.0 O.H.
    SIZE      0.000
    SPACE     0.000

CENTROID    12.370

GROSS MOMENT OF INERTIA    4580.00       SECTION MODULUS    370.25
NET MOMENT OF INERTIA      4580.00       SECTION MODULUS    370.25

RADIUS OF GYRATION OF COMP AREA ABOUT WEAK AXIS  3.02



SECTION 5  TYPE 5    36.00 FT FROM LEFT SUPPORT

ROLLED SECTION
     AREA 43.000       CENTROID 12.370    MOM INERTIA    4580.00


OPEN HOLES
    TOP FLANGE  0.0    0.000 IN. O.H.
    BOT FLANGE  0.0    0.000 IN. O.H.
    WEB  0.0 O.H.
    SIZE      0.000
    SPACE     0.000

CENTROID    12.370

GROSS MOMENT OF INERTIA    4580.00       SECTION MODULUS    370.25
NET MOMENT OF INERTIA      4580.00       SECTION MODULUS    370.25

RADIUS OF GYRATION OF COMP AREA ABOUT WEAK AXIS  3.02
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ASSOCIATION OF AMERICAN RAILROADS TECHNICAL CENTER
CHICAGO, ILLINOIS
REVISED DEC.1975

M N & S BRIDGE OVER BASSETT CREEK AT FRUEN MILL

GIRDER ANALYSIS

DECK PLATE GIRDER 36.00 FT SPAN

C-C GIRDERS 4.71 .167 AXLE LOAD TO EACH GIRDER

UNIFORM DEAD LOAD .213 KIPS/FT

DIESEL LOCOMOTIVE

UNBALLASTED DECK
1969 AREA SPECIFICATIONS

DEAD LOAD VALUES

UNIFORM DEAD LOAD .21 KIPS PER FT (EACH GIRDER)

POINT	DIST FROM LEFT SUPPORT (FT)	DEAD MOMENT (FT-KIPS)	DEAD SHEAR (KIPS)	PANEL (FT)
1	0.00	0.	4.	0.00
2	9.00	26.	2.	0.00
3	18.00	35.	0.	0.00
4	27.00	26.	-2.	0.00
5	36.00	0.	-4.	0.00

LIVE LOAD
(NO IMPACT)

POINT	DIST FROM LEFT SUPPORT (FT)	MOMENT (FT-KIPS)	POSITIVE SHEAR (KIPS)	NEGATIVE SHEAR (KIPS)	GROSS I (IN-4)	MODULUS (COMP) (IN-3)	COMP STRESS (KSI)	NET I (IN-4)	MODULUS (TEN) (IN-3)	TEN STRESS (KSI)	WEB AREA (IN-2)	WEB SHEAR (KSI)
1	0.00	0.	47.	0.	4580.	370.	0.00	4580.	370.	0.00	16.08	2.93
2	9.00	284.	30.	-2.	4580.	370.	9.20	4580.	370.	9.20	16.08	1.84

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3	18.00	366.	14.	-14.	4580.		
	370.	11.86	4580.	370.	11.86	16.08	.85
4	27.00	284.	2.	-30.	4580.		
	370.	9.20	4580.	370.	9.20	16.08	1.84
5	36.00	0.	0.	-47.	4580.		
	370.	0.00	4580.	370.	0.00	16.08	2.93

ASSOCIATION OF AMERICAN RAILROADS TECHNICAL CENTER
CHICAGO, ILLINOIS
REVISED DEC. 1975

M H & S BRIDGE OVER BASSETT CREEK AT FRUEN MILL

GIRDER ANALYSIS

DECK PLATE GIRDER 36.00 FT SPAN

C-C GIRDERS 4.71 .167 AXLE LOAD TO EACH GIRDER

UNIFORM DEAD LOAD .213 KIPS/FT

DIESEL LOCOMOTIVE

UNBALLASTED DECK
1969 AREA SPECIFICATIONS

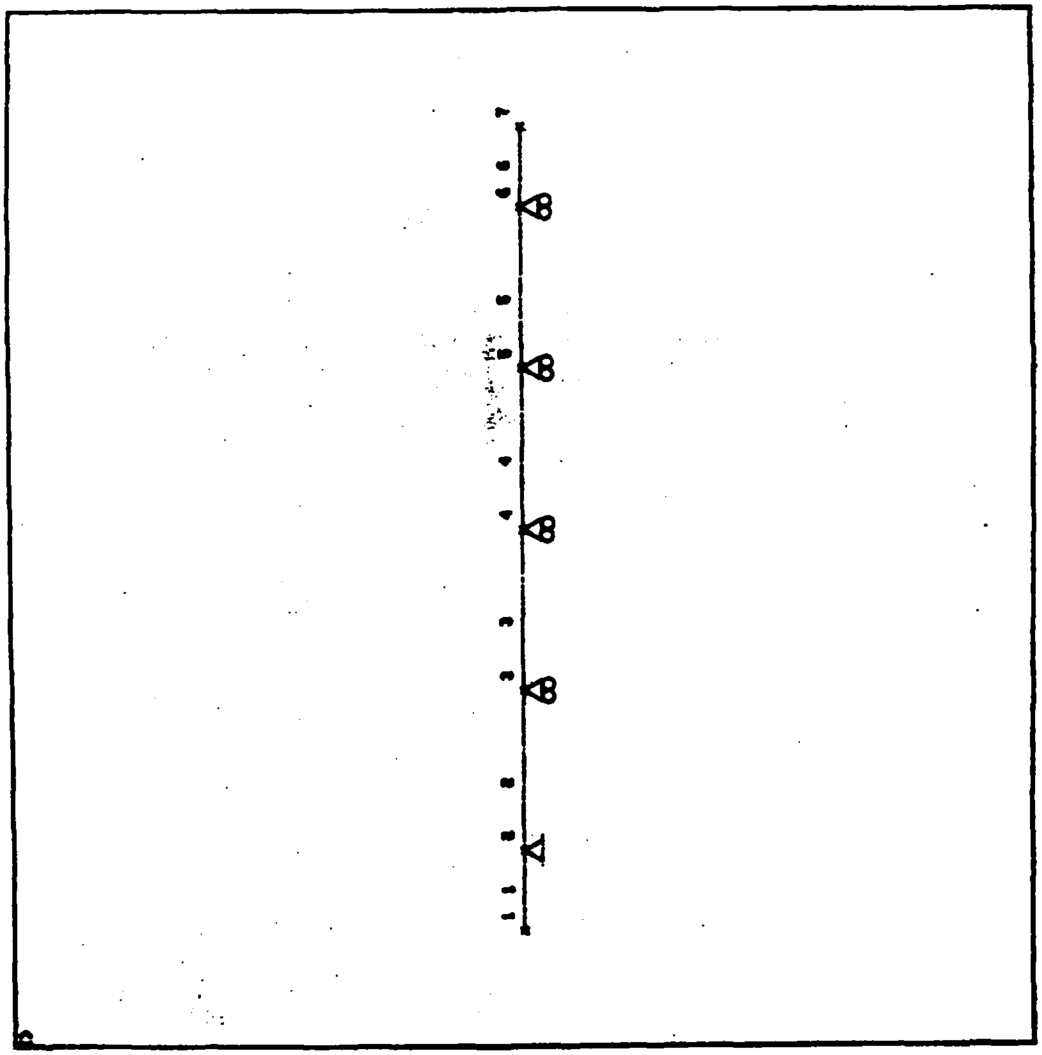
TOTALS

POINT	DIST FROM LEFT SUPPORT (FT)	DEAD MOMENT (FT-KIPS)	LIVE MOMENT (FT-KIPS)	IMPACT (FT-KIPS)	TOTAL MOMENT (FT-KIPS)
1	0.00	0.	0.	0.	0.
2	9.00	26.	284.	167.	477.
3	18.00	35.	366.	215.	615.
4	27.00	26.	284.	167.	477.
5	36.00	0.	0.	0.	0.

POINT	DEAD SHEAR (KIPS)	LIVE SHEAR (KIPS)	IMPACT (KIPS)	TOTAL SHEAR (KIPS)	COMP STRESS (KSI)	TEN STRESS (KSI)	SHEAR STRESS (KSI)
1	4.	47.	28.	79.	0.00	0.00	4.88
2	2.	30.	17.	49.	15.45	15.45	3.05
3	0.	14.	8.	22.	19.95	19.95	1.35
4	-2.	-30.	-17.	49.	15.45	15.45	3.05
5	-4.	-47.	-28.	79.	0.00	0.00	4.88

10/53

Intermediate Pier, Railroad Bridge Near Fruen Mill



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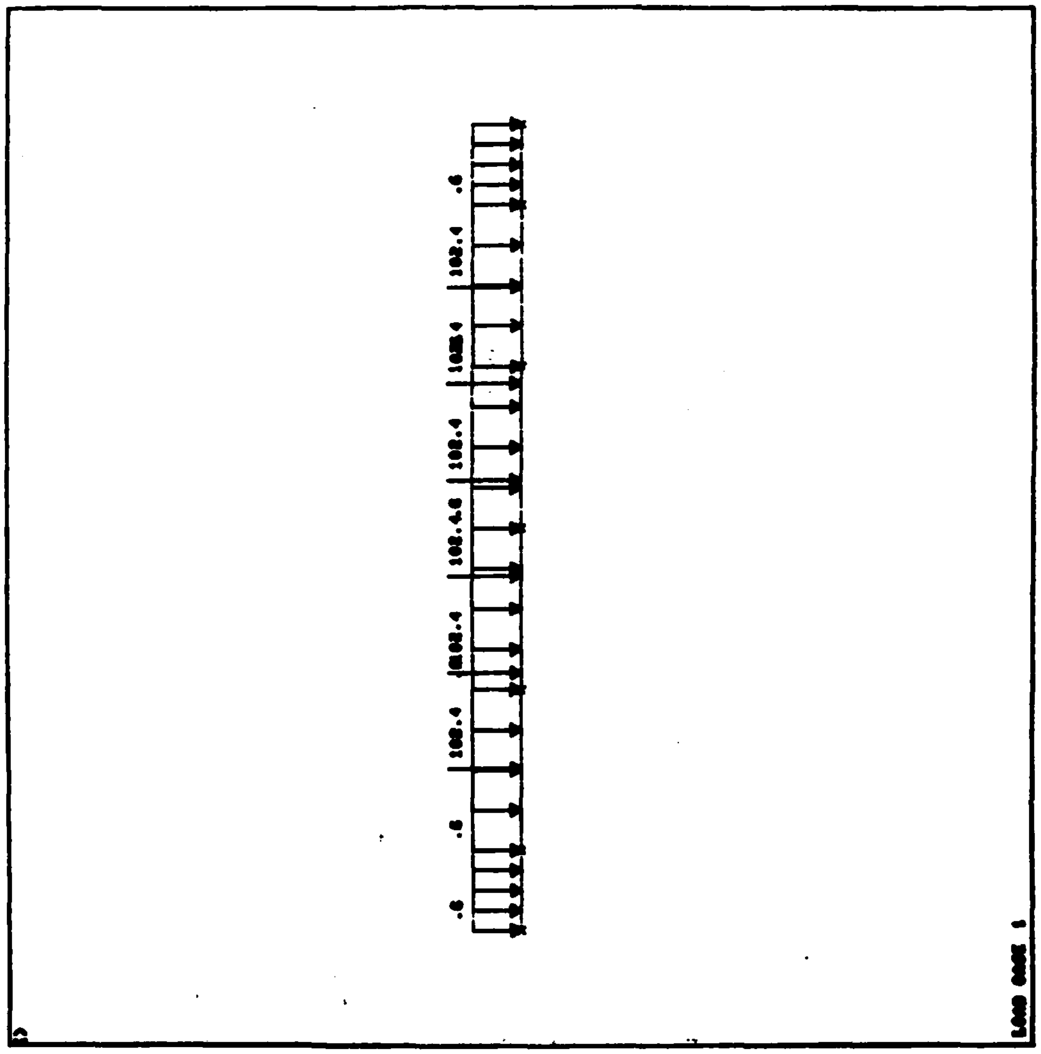

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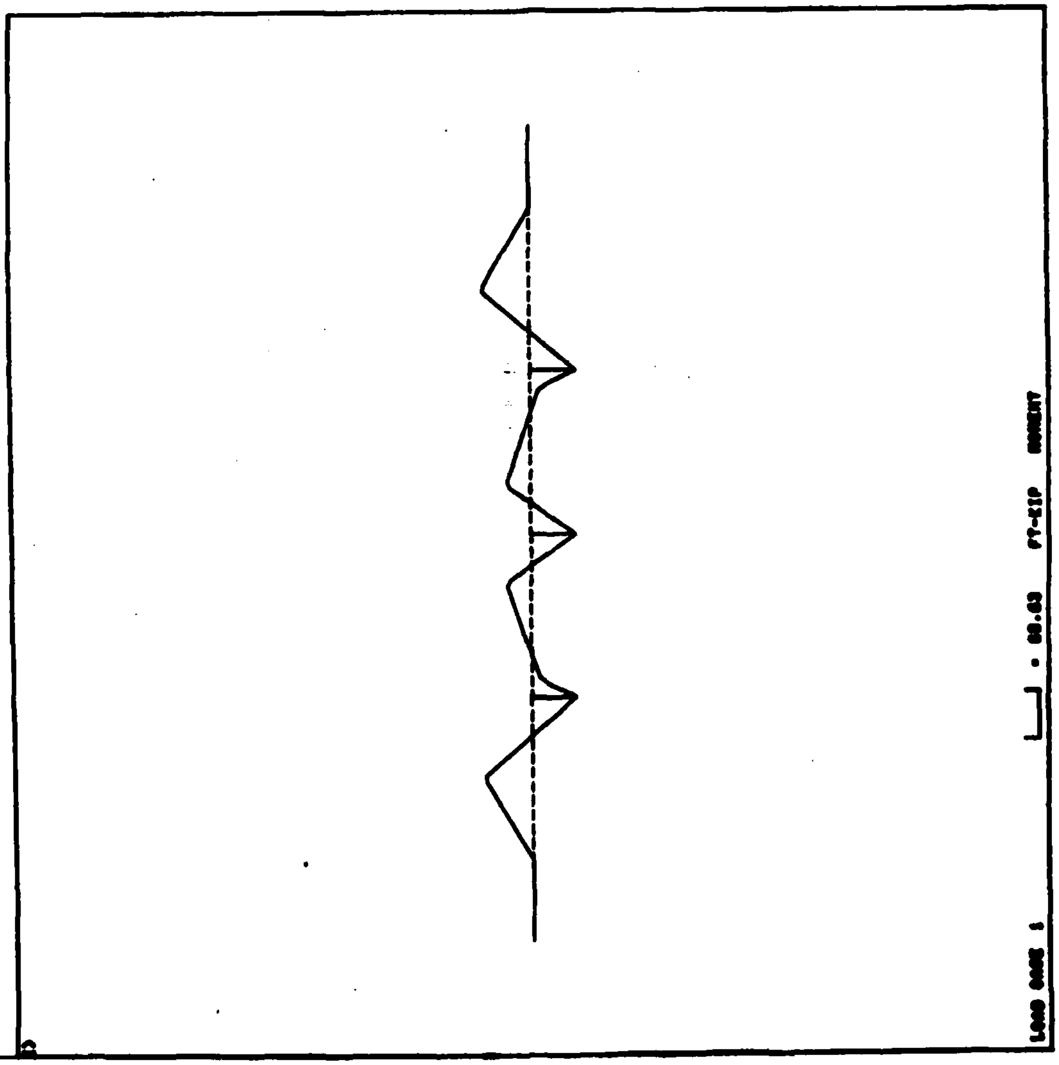
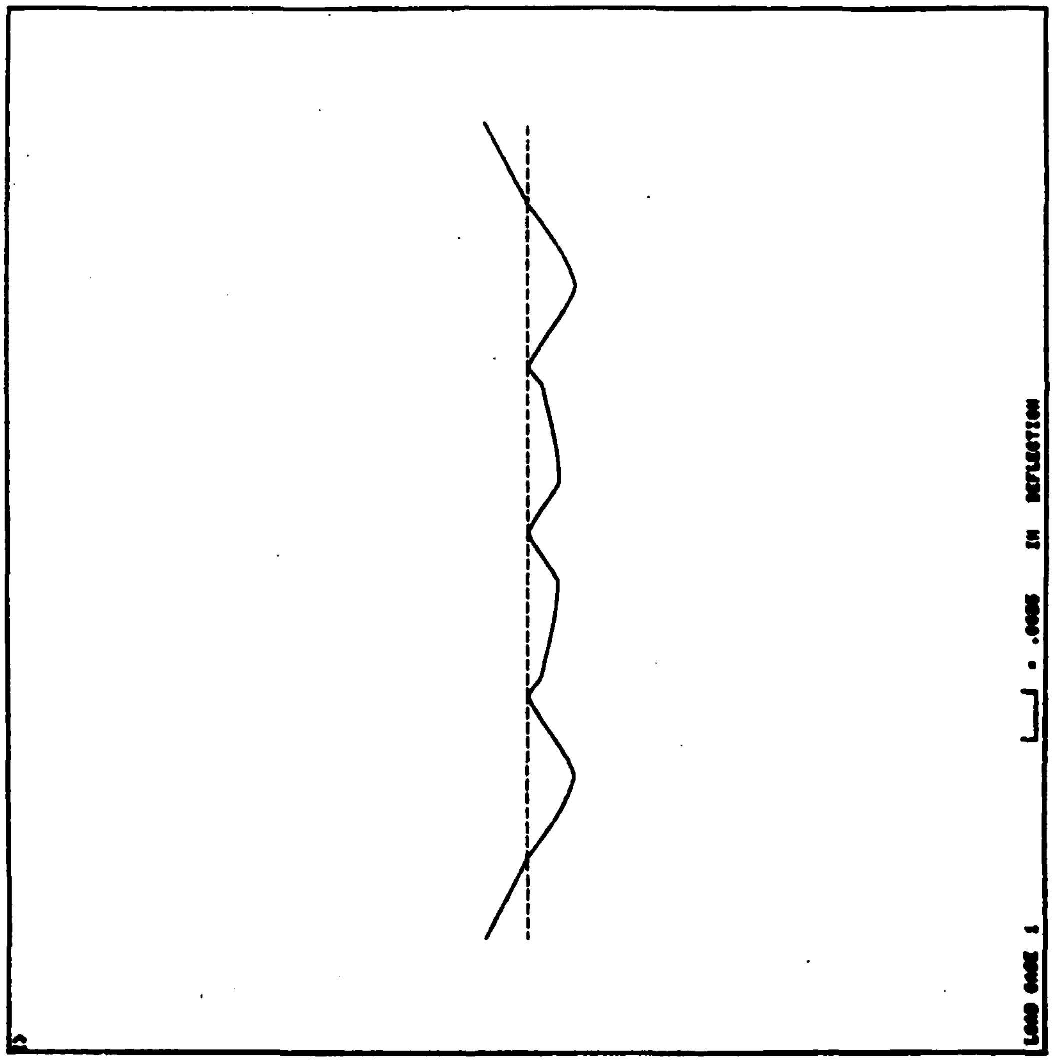
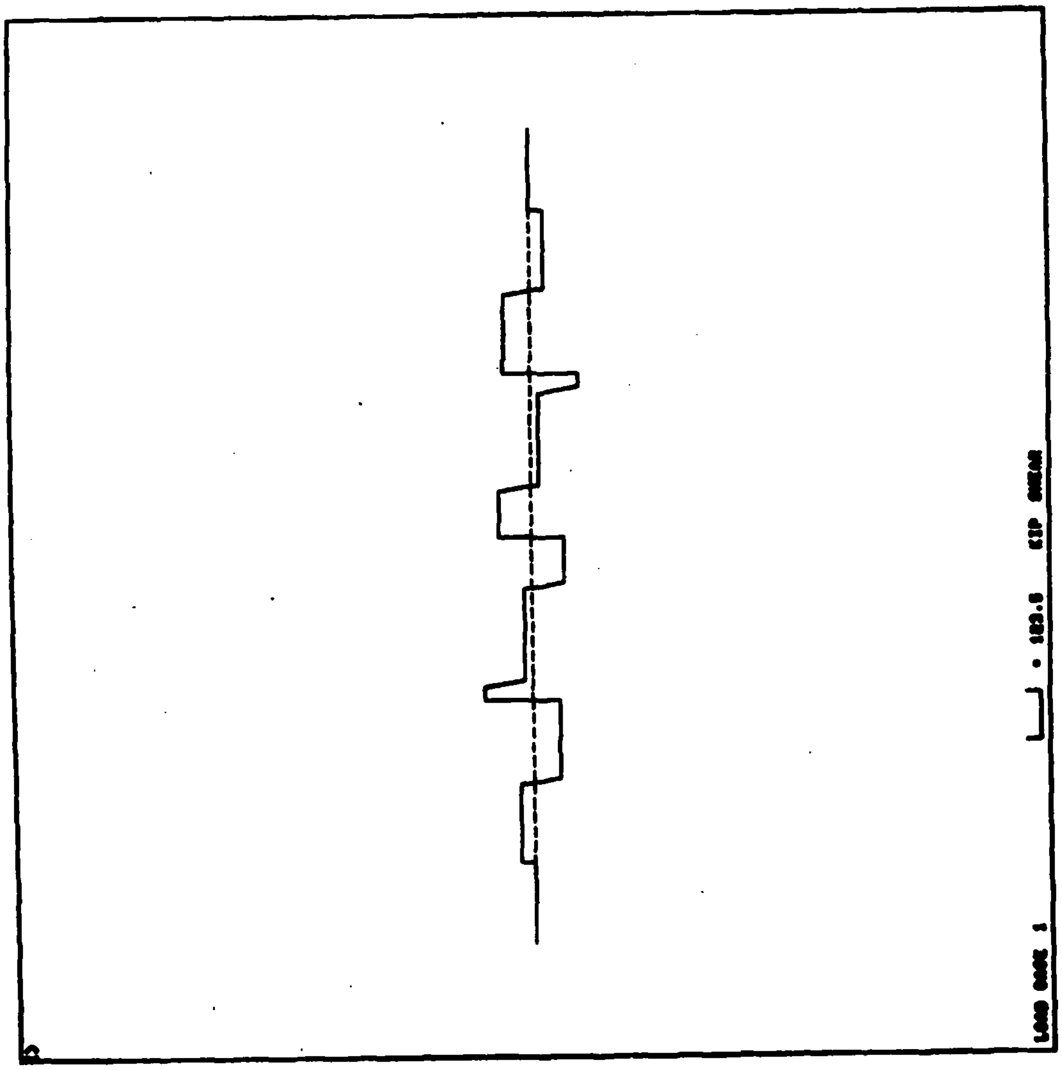



LOAD CASE 1
IN DEFLECTION


LOAD CASE 1
KIP SHEAR

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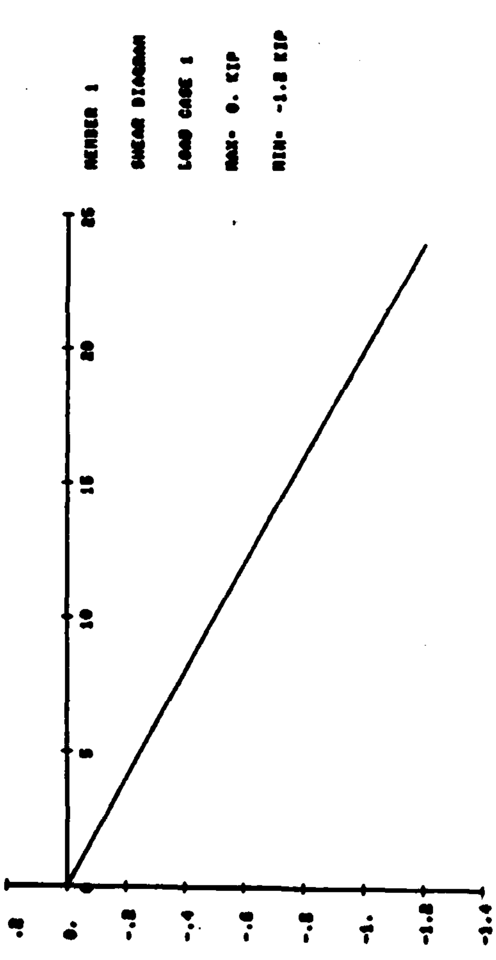
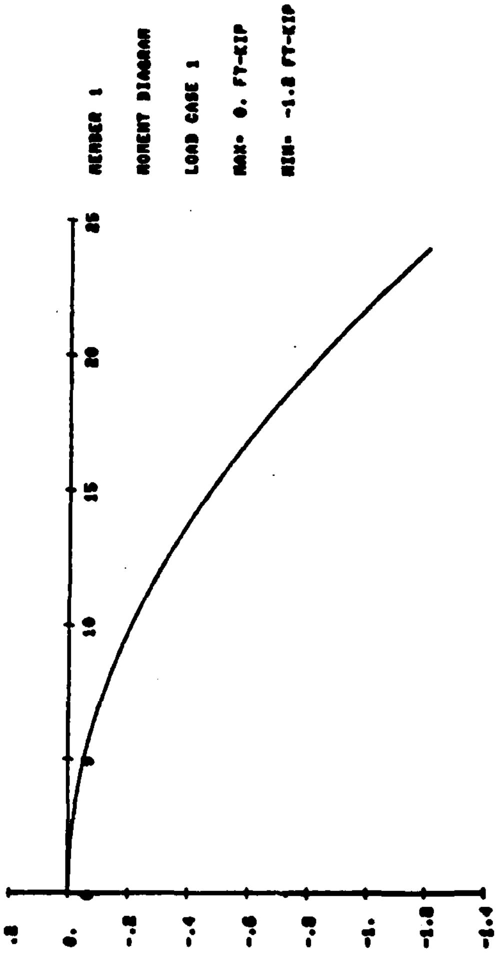

MEMBER 1
SHEAR DIAGRAM
LOAD CASE 1
MAX= 0. KIP
MIN= -1.2 KIP
0
5
10
15
20
25
.2
0.
-.2
-.4
-.6
-.8
-1.
-1.2
-1.4


MEMBER 1
MOMENT DIAGRAM
LOAD CASE 1
MAX= 0. FT-KIP
MIN= -1.2 FT-KIP
0
5
10
15
20
25
.2
0.
-.2
-.4
-.6
-.8
-1.
-1.2
-1.4

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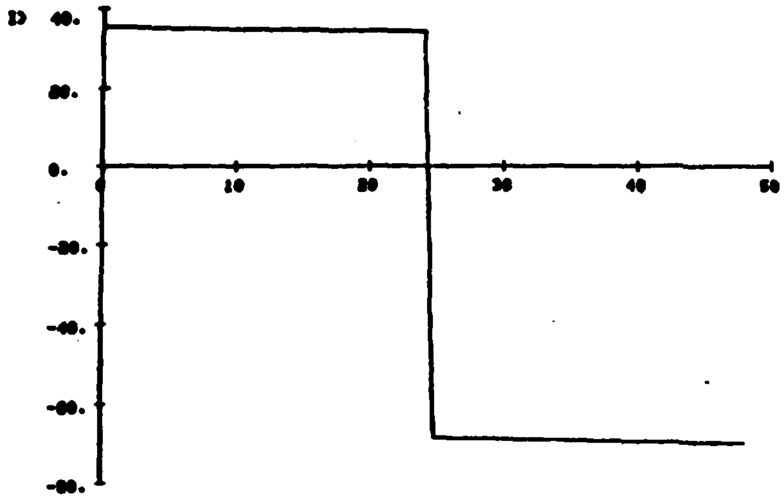


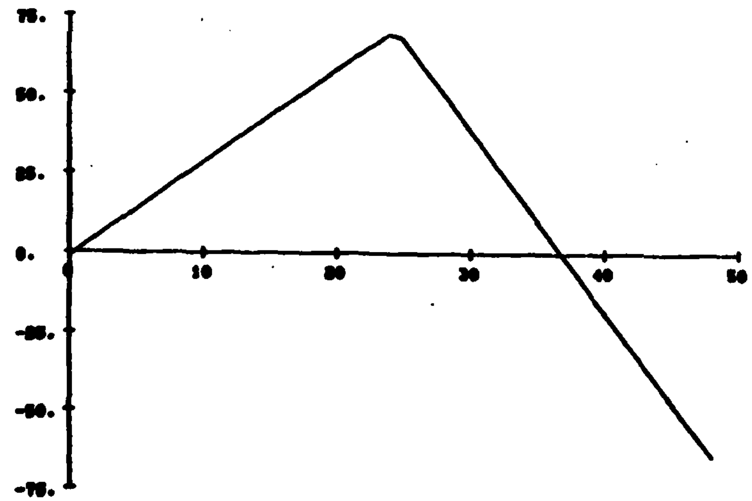
MEMBER 8

SHEAR DIAGRAM

LOAD CASE 1

MAX= 36.52 KIP

MIN= -68.86 KIP



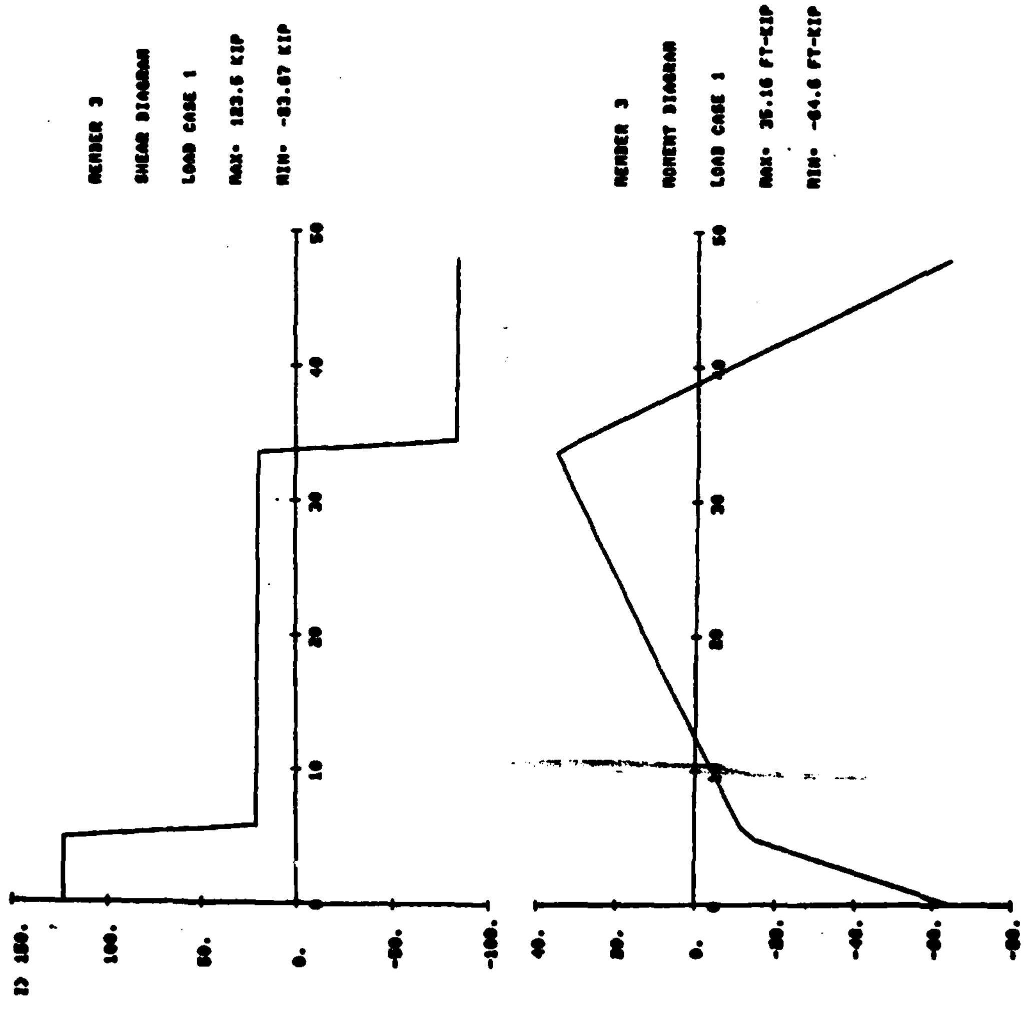
MEMBER 8

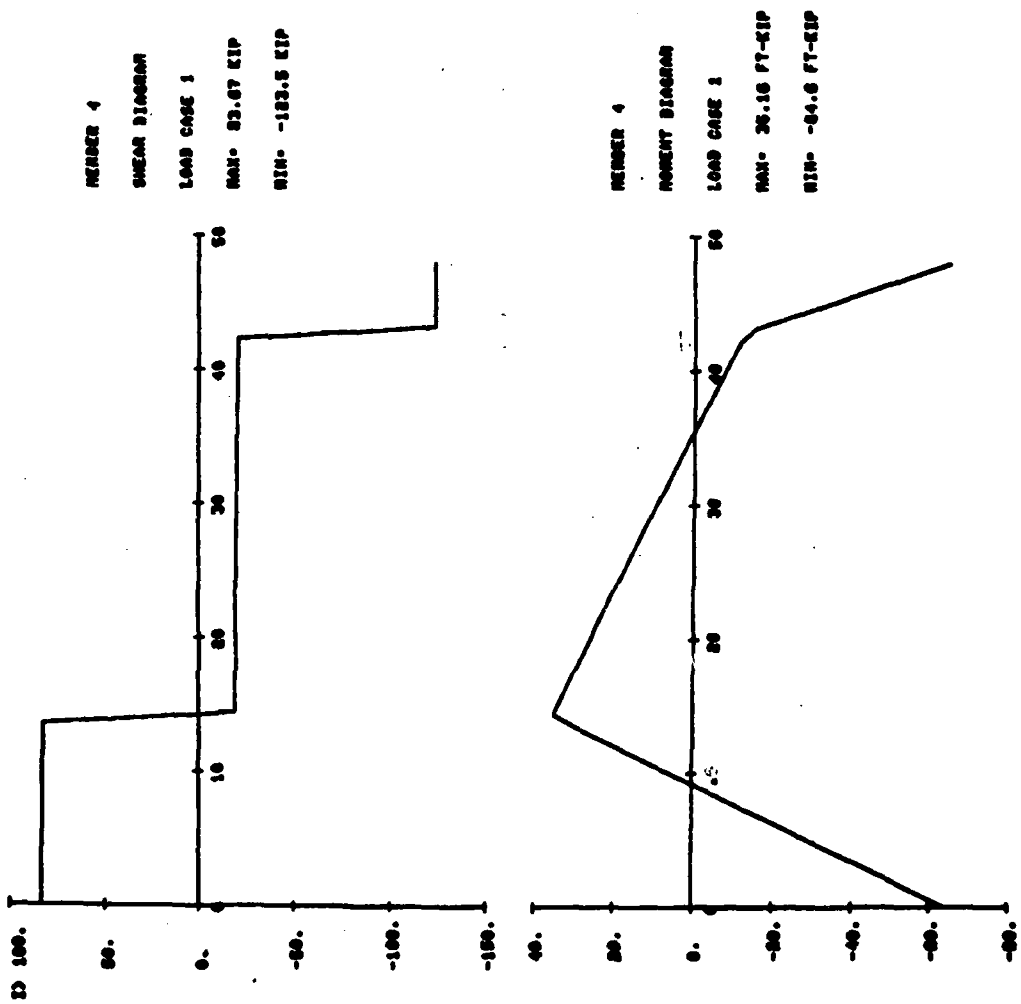
MOMENT DIAGRAM

LOAD CASE 1

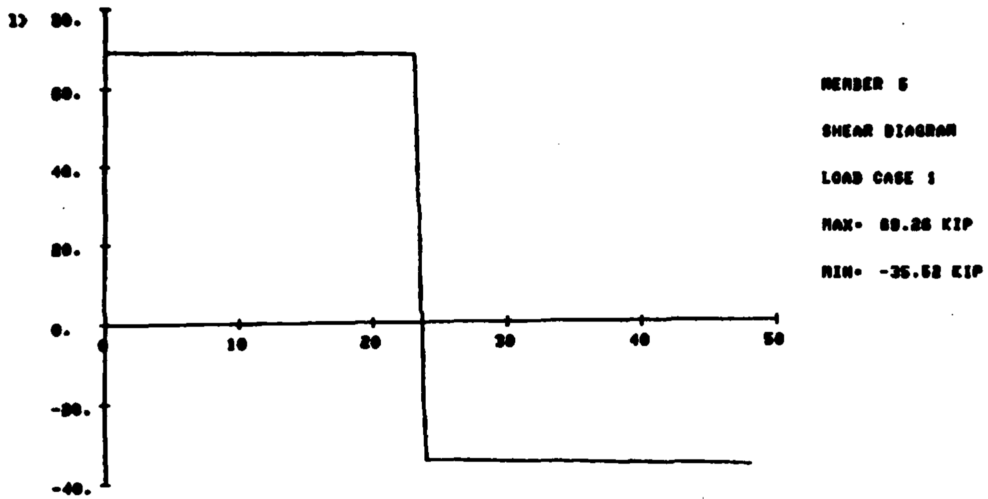
MAX= 68.63 FT-KIP

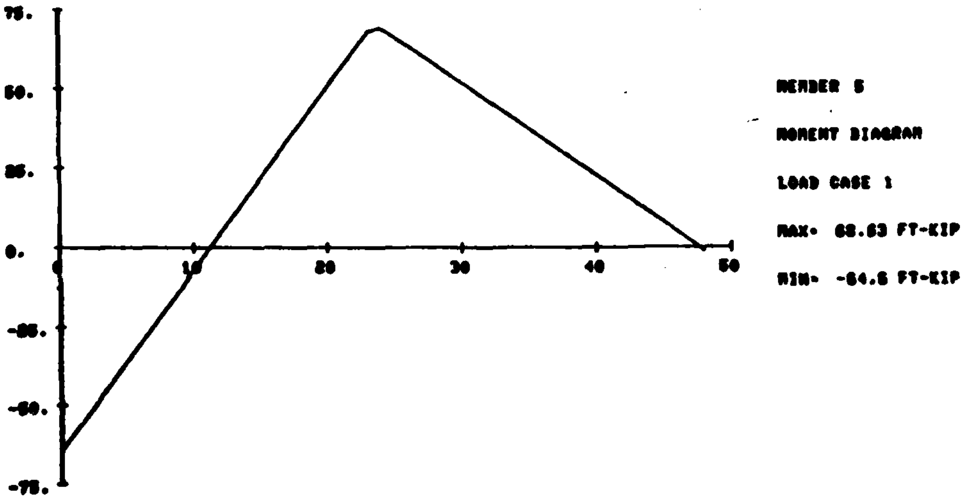
MIN= -64.6 FT-KIP

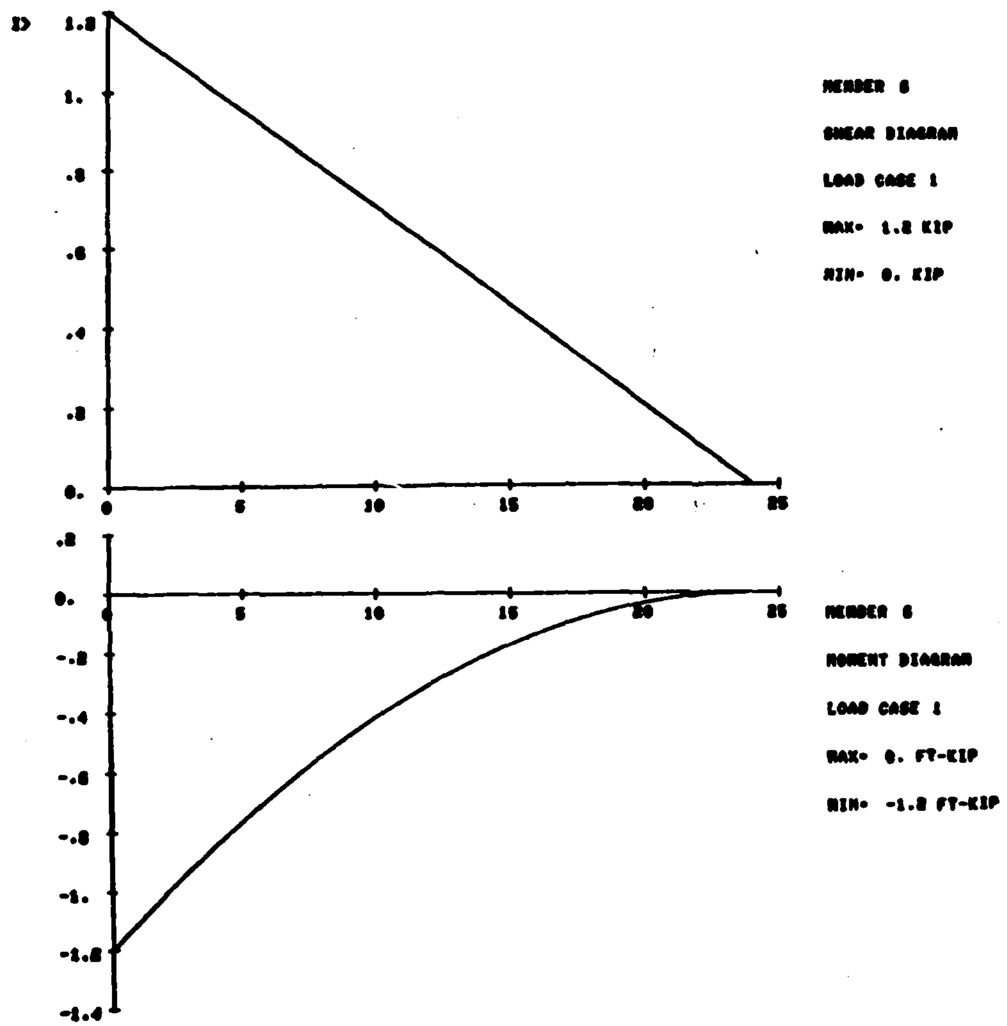

MEMBER 3
SHEAR DIAGRAM
LOAD CASE 1
MAX= 123.5 KIP
MIN= -83.87 KIP
MEMBER 3
MOMENT DIAGRAM
LOAD CASE 1
MAX= 35.16 FT-KIP
MIN= -64.6 FT-KIP
0
10
20
30
40
50
150.
100.
50.
0.
-50.
-100.
40.
20.
0.
-20.
-40.
-60.
-80.



MEMBER 4
SHEAR DIAGRAM
LOAD CASE 1
MAX= 83.07 KIP
MIN= -123.5 KIP
MEMBER 4
MOMENT DIAGRAM
LOAD CASE 1
MAX= 36.16 FT-KIP
MIN= -64.6 FT-KIP
100.
50.
0.
-50.
-100.
-150.
40.
20.
0.
-20.
-40.
-60.
-80.
0
10
20
30
40
50


MEMBER 5
SHEAR DIAGRAM
LOAD CASE 1
MAX= 69.26 KIP
MIN= -35.52 KIP
80.
60.
40.
20.
0.
-20.
-40.
10
20
30
40
50


MEMBER 5
MOMENT DIAGRAM
LOAD CASE 1
MAX= 68.63 FT-KIP
MIN= -64.5 FT-KIP
75.
50.
25.
0.
-25.
-50.
-75.
10
20
30
40
50


1.2
1.
.8
.6
.4
.2
0.
0
5
10
15
20
25
MEMBER 6
SHEAR DIAGRAM
LOAD CASE 1
MAX= 1.2 KIP
MIN= 0. KIP
.2
0.
-.2
-.4
-.6
-.8
-1.
-1.2
-1.4
MEMBER 6
MOMENT DIAGRAM
LOAD CASE 1
MAX= 0. FT-KIP
MIN= -1.2 FT-KIP

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1$-$-$-$-$-$-$-$-$-$-$-$-$-$-$
PROGRAM CFRAME V01.05 05JUL79
$-$-$-$-$-$-$-$-$-$-$-$-$-$-$

RUN DATE = 81/08/18.
RUN TIME = 06.01.08.

INTERMEDIATE PIER FOR M N & S RR NEAR FRUEN MILL

1 $$$ JOINT DATA $$$

JOINT	X (FT)	Y (FT)	FIXITY X	FIXITY Y	FIXITY R	KX (KIP/IN)	KY (KIP/IN)	KR (IN-KIP/RAD)
1	0.00	0.00						
2	2.00	0.00	$	$				
3	6.00	0.00		$				
4	10.00	0.00		$				
5	14.00	0.00		$				
6	18.00	0.00		$				
7	20.00	0.00						

1 $$$ MEMBER DATA $$$

MEMBER	END A	END B	LENGTH FT	I FT$$4	A FT$$2	AS FT$$2	E KSI	G KSI
1	1	2	2.00	.1333E+01	.4000E+01	.4000E+01	.3834E+04	.1598E+04
2	2	3	4.00	.1333E+01	.4000E+01	.4000E+01	.3834E+04	.1598E+04
3	3	4	4.00	.1333E+01	.4000E+01	.4000E+01	.3834E+04	.1598E+04
4	4	5	4.00	.1333E+01	.4000E+01	.4000E+01	.3834E+04	.1598E+04
5	5	6	4.00	.1333E+01	.4000E+01	.4000E+01	.3834E+04	.1598E+04
6	6	7	2.00	.1333E+01	.4000E+01	.4000E+01	.3834E+04	.1598E+04

1 $$$ LOAD CASE 1 DATA $$$

MEMBER	LA FT	PA KIP/FT	LB FT	PB KIP/FT	ANGLE DEG
1	0.00	.6000E+00	2.00	.6000E+00	0.00
2	0.00	.6000E+00	4.00	.6000E+00	0.00
3	0.00	.6000E+00	4.00	.6000E+00	0.00
4	0.00	.6000E+00	4.00	.6000E+00	0.00
5	0.00	.6000E+00	4.00	.6000E+00	0.00
6	0.00	.6000E+00	2.00	.6000E+00	0.00

D

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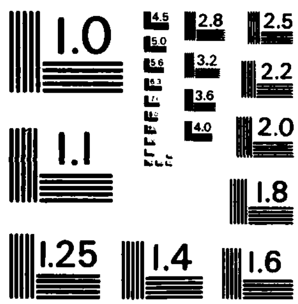
AD-A133 795 BASSETT CREEK WATERSHED HENNEPIN COUNTY MINNESOTA FEASIBILITY REPORT FOR FLOOD CONTROL MAIN REPORT(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 82

5/7

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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1*-*-*-*-*-*-*-*-*-*-*-*-*-*-*
 PROGRAM CFRAME V01.05 08JUL79
 *-*-*-*-*-*-*-*-*-*-*-*-*-*-*

 RUN DATE :  81/05/18.
 RUN TIME :  08.01.05.

 INTERMEDIATE PIER FOR M N & S RR NEAR FRUEN MILL
1 *** JOINT DATA ***

                               ------------------FIXITY-------------------
 JOINT      X          Y     X  Y  R       KX           KY              KR
          ----FT----                       ----KIP/IN----          IN-KIP/RAD

    1      0.00       0.00
    2      2.00       0.00   *  *
    3      6.00       0.00      *
    4     10.00       0.00      *
    5     14.00       0.00      *
    6     18.00       0.00      *
    7     20.00       0.00
1 *** MEMBER DATA ***

        END END
 MEMBER  A   B    LENGTH      I           A           AS          E           G
                    FT      FT**4       FT**2       FT**2        KSI         KSI

    1    1   2     2.00  .1333E+01   .4000E+01   .4000E+01   .3834E+04   .1598E+04
    2    2   3     4.00  .1333E+01   .4000E+01   .4000E+01   .3834E+04   .1598E+04
    3    3   4     4.00  .1333E+01   .4000E+01   .4000E+01   .3834E+04   .1598E+04
    4    4   5     4.00  .1333E+01   .4000E+01   .4000E+01   .3834E+04   .1598E+04
    5    5   6     4.00  .1333E+01   .4000E+01   .4000E+01   .3834E+04   .1598E+04
    6    6   7     2.00  .1333E+01   .4000E+01   .4000E+01   .3834E+04   .1598E+04
1 *** LOAD CASE   1 DATA ***

 MEMBER   LA       PA         LB       PB        ANGLE
          FT     KIP/FT       FT     KIP/FT       DEG

    1    0.00   .6000E+00    2.00   .6000E+00    0.00
    2    0.00   .6000E+00    4.00   .6000E+00    0.00
    3    0.00   .6000E+00    4.00   .6000E+00    0.00
    4    0.00   .6000E+00    4.00   .6000E+00    0.00
    5    0.00   .6000E+00    4.00   .6000E+00    0.00
    6    0.00   .6000E+00    2.00   .6000E+00    0.00

D
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MEMBER	L FT	P KIP	ANGLE DEG
2	2.04	.1024E+03	0.00
3	.42	.1024E+03	0.00
3	2.81	.1024E+03	0.00
4	1.19	.1024E+03	0.00
4	3.58	.1024E+03	0.00
5	1.86	.1024E+03	0.00

1 LOAD CASE 1

JOINT DISPLACEMENTS

JOINT	DX IN	DY IN	DR RAD
1	0.	.2275E-02	-.9517E-04
2	0.	0.	-.9626E-04
3	0.	0.	0.
4	0.	0.	0.
5	0.	0.	0.
6	0.	0.	.9626E-04
7	0.	.2275E-02	.9517E-04

MEMBER END FORCES

MEMBER	JOINT	AXIAL KIP	SHEAR KIP	MOMENT FT-KIP	MOMENT EXTREMA FT-KIP	LOCATION FT
1	1	0.	0.	0.	0.	0.00
	2	0.	.1200E+01	-.1200E+01	-.1200E+01	2.00
2	2	0.	.3552E+02	-.1200E+01	.8863E+02	2.00
	3	0.	.6926E+02	-.6460E+02	-.6460E+02	4.00
3	3	0.	.1235E+03	-.6460E+02	.3516E+02	2.80
	4	0.	.8367E+02	-.8378E+02	-.6460E+02	0.00
4	4	0.	.8367E+02	-.8378E+02	.3516E+02	1.20
	5	0.	.1235E+03	-.6460E+02	-.6460E+02	4.00
5	5	0.	.6926E+02	-.6460E+02	.8863E+02	2.00
	6	0.	.3552E+02	-.1200E+01	-.6460E+02	0.00
6	6	0.	.1200E+01	-.1200E+01	0.	2.00
	7	0.	0.	0.	-.1200E+01	0.00

STRUCTURE REACTIONS

JOINT	FORCE X	FORCE Y	MOMENT

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STRUCTURE REACTIONS

JOINT	FORCE X KIP	FORCE Y KIP	MOMENT FT-KIP
2	0.	[illegible]	0.
3	0.	[illegible]	0.
4	0.	.1673E+03	0.
5	0.	[illegible]	0.
6	0.	[illegible]	0.
TOTAL	0.	[illegible]	

END.

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NCD 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 68)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 17 August 1981	PAGE 24 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION Intermediate Pier		
SUBJECT Bassett Creek	SOURCE DATA AREA		
COMPUTED BY GLC	CHECKED BY	APPROVED BY	

Check Adequacy of 2'x2' Pile Cap

$M_{max} = 68.63^{\prime K}$

$$M_{\bar{u}} = \frac{1.8(68.63)}{.9} = 137.26^{\prime K}$$

$$R_u = \frac{M_{\bar{u}}}{bd^2} = \frac{137.26(12000)}{24(21.5)^2} = 148.47 \text{ psi}$$

Use $f'_c = 4000$ psi $f_y = 60{,}000$ psi $\qquad m = \frac{f_y}{.85f'_c} = 17.65$

$$\rho = \frac{1}{m}\left(1 - \sqrt{1 - \frac{2mR_u}{f_y}}\right) = .00253$$

$$\rho_{min} = \frac{200}{f_y} = .003333$$

$$A_s = \rho bd = .00333(24)(21.5) = 1.72 \text{ in}^2$$

Max $V = 123.5$

$$v_u = \frac{V_u}{\phi bd} = \frac{1.8(123.5)(1000)}{.85(24)(21.5)} = 506 \text{ psi}$$

$v_c = 2\sqrt{f'_c} = 126.49$ Pg 8-2-41

$v_u - v_c \leq 8\sqrt{f'_c} = 506$ Section 2.35.3 Pg 8-2-42

$\therefore$ OK

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 18 Aug 1981	PAGE 25 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION Piling Design		
SUBJECT Bassett Creek, Fruen Mill	SOURCE DATA		
COMPUTED BY G.L.C.	CHECKED BY	APPROVED BY	

For 16"OD pipe pile, using skin friction, then

surface area/LF. of pile = $\pi \frac{16}{12} = 4.19\ ft^2$

$\therefore$ Capacity $= \sum$(Depth of pile in layer)($4.19\ ft^2$)(q {#/ft² of surface area})

Boring 80-39M

Elevation	Material	q	P	ΣP
809				
	CL	1000	12.57	12.57
806				
	SP	200	.84	13.40
805				
	GP	2000	75.40	88.80
796				
	SP	2000	83.78	172.58
786				

Boring 80-34M

Elevation	Material	q	P	ΣP
809				
	GP	2000	8.38	8.38
808				
	CL	1500	94.25	102.63
793				
	SP	800	6.70	109.33
791				
	GP	2000	58.64	167.97
784				

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 65)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 18 Aug 1981	PAGE 26 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION Intermediate Pier		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY GLC	CHECKED BY	APPROVED BY	

Redesign Piles

Max P = 192.8^K

Boring 80-39M (Page 2)

Below 786 = $\dfrac{192.8 - 172.58}{2(4.17)} = 2.41$

∴ Bottom elev at 786 - 2.4 = 783.59 use 783.5

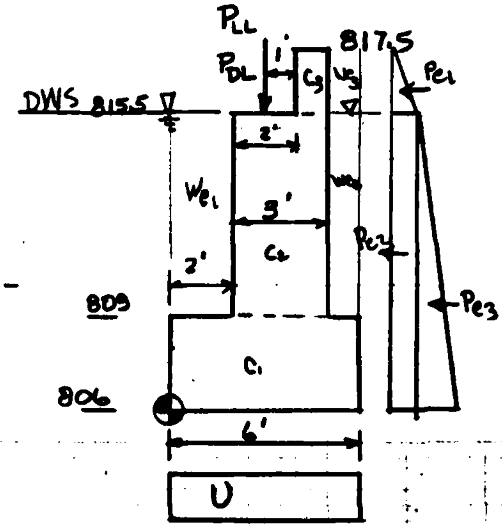
Boring 80-34M

Below 784 = $\dfrac{192.8 - 167.97}{2(4.17)} = 2.96$

784 - 2.96 = 781.04 use 781

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 12/15/81	PAGE 27 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION MN&S RR Abutment		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY GLC	CHECKED BY	APPROVED BY	

Abutment Stability (One Foot Strip)



P_{DL} is girder weight. Since P_{DL} is 1.5' on centers, then $P_{DL} = 3828^{\#}/1.5 = 2552^{\#}$

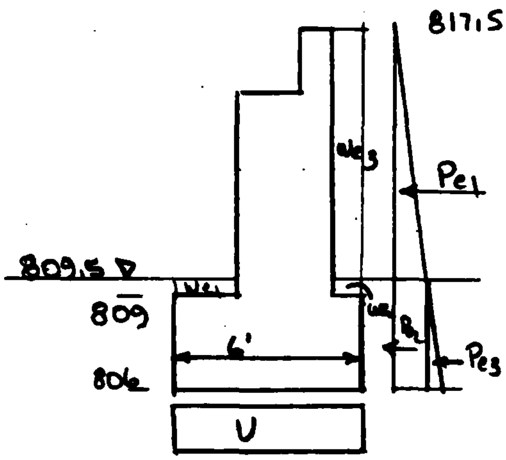
$P_{LL} = \frac{141.12^k}{3} = 47040^{\#}$ @ 1.5' on centers

$\therefore P_{LL} = \frac{47040}{1.5} = 31360^{\#}$

SYM	FACTOR	↓+ FORCES	←+	ARM	↻ MOMENT	↺
C1	3(6)(150)	2700		3.0	8100	
C2	3(6.5)(150)	2925		3.5	10237.5	
C3	1(2)(150)	300		4.5	1350	
We1	6.5(2)(62.5)	812.5		1.0	812.5	
We2	6.5(1)(130)	845		5.5	4647.5	
We3	1(2)(120)	240		5.5	1320	
U	6(9.5)(62.5)	-3562.5		3		10687.5
Pe1	$(2)^2(1/2)(120*.5)$		120	10.17		1220.4
Pe2	2(120*.5) 9.5		1140	9.5/2		5415
Pe3	$(130-62.5)(9.5)^2(1/2)(.5)$		1523.0	9.5/3		4822.7
P_{DL}		2552		3.0	7656	
		6812	2783	1.76	34123.5	22145.6
				Σ	11978	
P_{LL}		31360		3	94080	
		38172	2783	2.78	128203.5	22145.6
				ΣM	106058	

NCS 14
1 JUNE 75 (REPLACES NCD 14, 1 APR 68)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 12/15/81	PAGE 28 OF 33	FILE NUMBER
NAME OF OFFICE		COMPUTATION MN&S RR Abutment	
SUBJECT Bassett Creek		SOURCE DATA	
COMPUTED BY G.L.C.	CHECKED BY	APPROVED BY	



SYM	FACTORS	↓+ FORCES	←+	ARM	↻ MOMENT	↺
C_1		2700		3.0	8100	
C_2		2925		3.5	10237.5	
C_3		300		4.5	1350	
We_1	.5(2)(62.5)	62.5		1.0	62.5	
We_2	.5(1)(130)	65.0		5.5	357.5	
We_3	8(1)(120)	960		5.5	5280	
U	6(3.5)(62.5)	(-) 1312.5		3.0		3937.5
Pe_1	$(8)^2(1/2)(120\#.5)$		1920	6.17		11840
Pe_2	8(120#.5)(3.5)		1680	3.5/2		2940
Pe_3	$(130-62.5)(3.5)^2(1/2)(.5)$		206.7	3.5/3		241.2
P_{DL}		2552		3.0	7656	
		8252	3806.7		33093.5	18958.7
				1.71	ΣM = 14084.8	
P_{LL}		31360		3	94080	
		39612	3806.7	2.73	127173.5	18958.7

ΣM = 108165

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 12/15/81	PAGE 29 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY GLC	CHECKED BY	APPROVED BY	

Since stability analysis was performed on a one foot strip, the total vertical force must be compute

For DWS without railroad load

$\Sigma V = 37(6812-2552) + 6(3828) = 180588^{\#}$

For DWS with railroad load

$\Sigma V = 180588 + 6(47040) = 462828^{\#}$

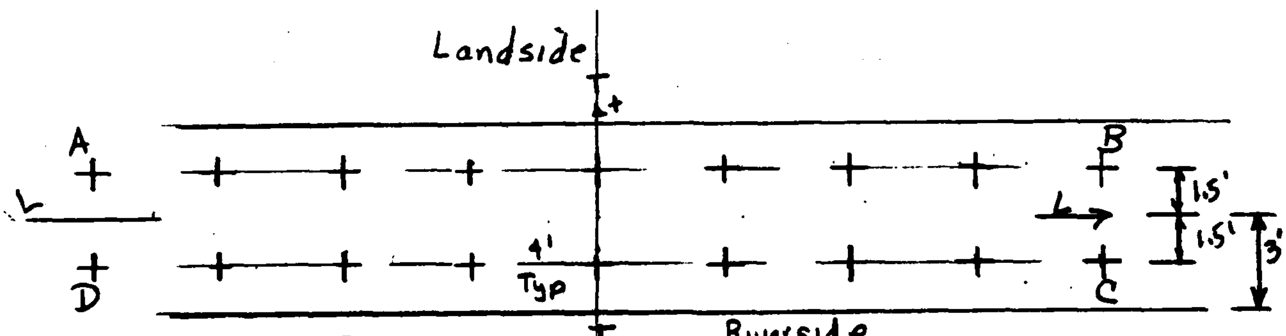
For NWS without railroad load

$\Sigma V = 37(8252-2552) + 6(3828) = 233868$

For NWS with railroad load

$\Sigma V = 233868 + 6(47040) = 516108$

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 12/23/81	PAGE 30 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION MN&S R.R. Bridge		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY G.L.C	CHECKED BY	APPROVED BY	



$I_L = 2(9)(1.5)^2 = 40.5\ ft^3$ $N = 18$

$I_T = 4(4)^2 + 4(8)^2 + 4(12)^2 + 4(16)^2 = 1920\ ft^3$

Loadcase DWS case

1 Without train load $e = 1.76 - 3 = -1.24$

2 With train load $e = 2.78 - 3 = -0.22$

Normal Water Case

3 Without train load $e = 1.71 - 3 = -1.29$

4 With train load $e = 2.73 - 3 = -0.27$

Pile A & B $\frac{\Sigma V}{18} + \frac{\Sigma V e (1.5)}{40.5}$

Pile	Loading Case	ΣV	e	Pile Load (lbs)	Pile Load (Tons)
A & B	1	180588	-1.24	1739	.87
	2	462828	-0.22	21941	10.97
	3	233868	-1.29	1819	.91
	4	516108	-0.27	23512	11.76
C & D	1	180588	-1.24	18326	9.16
	2	462828	-0.22	29484	14.74
	3	233868	-1.29	24166	12.08
	4	516108	-0.27	33834	16.92 ← Max pile load

Determine pile penetration below 806

		q	P	ΣP
806				
805	SP	200	.84	.84
	GP	2000		

Below 805 = $\frac{33834 - .8}{2(4.19)}$ = 3.94' Bottom elev = 805 - 4 = 801

∴ Redesign - Too many piles

D-63

NCS 14
1 JUNE 78 (REPLACES NCD 14, 1 APR 68)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 12/24/81	PAGE 31 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION MNS RR Bridge		
SUBJECT Bassett Creek	SOURCE DATA AREA		
COMPUTED BY G.L.C.	CHECKED BY	APPROVED BY	

Check adequacy of 16"ϕ pipe piles

Minimum wall thickness of 3/8" by PP 4.4.3.3

Allowable stresses PP 4.4.5.6

$f_c = .3f'_c < 1200$ psi

$f_s = 12{,}600$ psi

for a 16"ϕ, 3/8" thick $A_s = 18.41 in^2$ $A_c = 182.6 in^2$
From PILETIPS – Design and Installation of Pile Foundations

$P = f'_c A_c + f_s A_s = 182.6(.3*4000) + 18.41(12{,}600)$

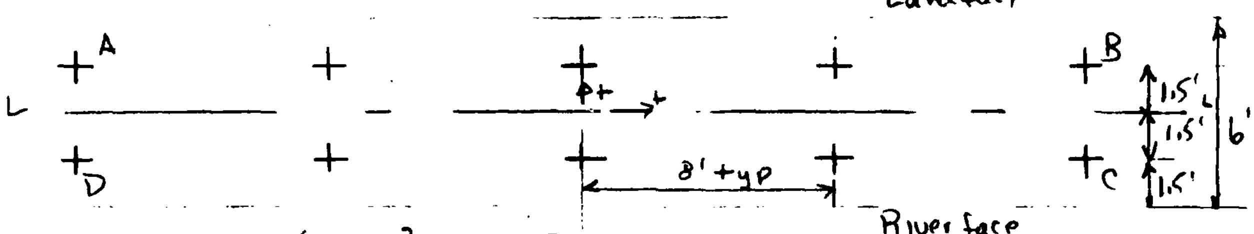
$= 231966 + 219120 = 451{,}086 k$

∴ Any pile loads will be significantly less than the pile capacity.

NCS 14
1 JUNE 79 (REPLACES NCD 14, 1 APR 68)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 12/24/81	PAGE 32 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION M N & S R.R. Bridge		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY G.L.C	CHECKED BY	APPROVED BY	

Revise pile layout



$I_{LL} = 2(5)(1.5)^2 = 22.5$ $N = 10$ piles

Load Case   DWS
1   without train $e = 1.76 - 3 = -1.24'$
2   with train $e = 2.78 - 3 = -0.22$
Normal Water Surface
3   Without train $e = 1.71 - 3 = -1.29'$
4   with train $e = 2.73 - 3 = -0.27'$

Piles A & B $P = \frac{\Sigma V}{N} + \frac{\Sigma V e\,(1.5)}{I_{LL}}$ Piles C & D $P = \frac{\Sigma V}{N} + \frac{\Sigma V e\,(-1.5)}{I_{LL}}$

Pile	Loading Case	ΣV	e	Pile Load	
		lb	ft	lbs	Tons
A & B	1	180588	-1.24	3130	1.57
	2	462828	-0.22	39495	19.75
	3	233868	-1.29	3274	1.64
	4	516108	-0.27	42321	21.16
C & D	1	180588	-1.24	32987	16.49
	2	462828	-0.22	53071	26.54
	3	233868	-1.29	43499	21.75
	4	516108	-0.27	60901	30.45 ← Max Pile Load

Determine Pile Penetration

		q	$P_o\,m(\frac{k}{ft})$ kips	ΣP
806	SP	20	.84	.84
805	GP	2000		

Below 805 $= \frac{60901 - .84}{2(4.19)} = 7.17'$ Bottom elev. $805 - 7.17 = 797.83$
use 797.5

D-65

ST. PAUL DISTRICT COMPUTATION SHEET	DATE 12/24/81	PAGE 33 OF 33	FILE NUMBER
NAME OF OFFICE	COMPUTATION MN&S RR Bridge		
SUBJECT Bassett Creek	SOURCE DATA		
COMPUTED BY GLC	CHECKED BY	APPROVED BY	

Determine Pile Batter

$$\text{Batter} = m = 12 \frac{\Sigma H}{\Sigma V}$$

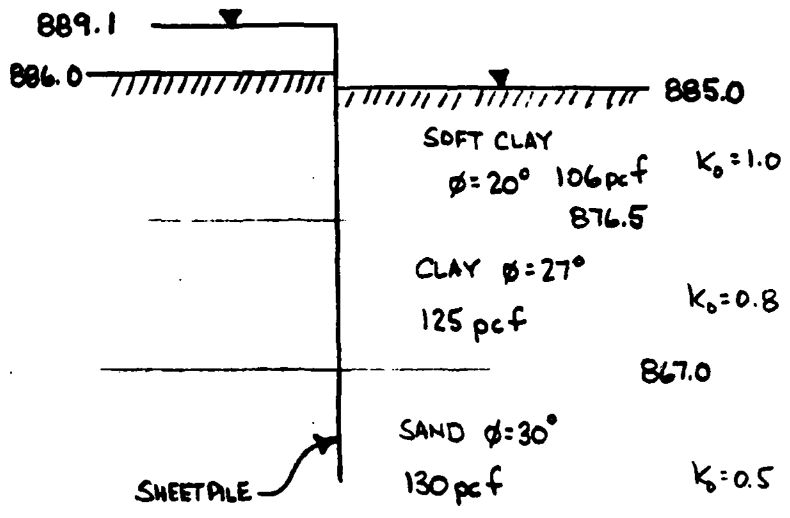
$\Sigma H = 37(\Sigma H/\text{foot})$ $\Sigma V = 5(\text{Pile C\&D})$

LC	ΣH/ft	ΣH	ΣV/pile	ΣV	m
1	2783	102971	32987	164935	7.49
2	2783	102971	53071	265355	4.66
3	3806.7	140848	43499	217495	7.77 ← Governs
4	3806.7	140848	60901	304505	5.55

Use Batter of $\frac{7.77}{12} \simeq 30^\circ$ $\therefore$ use batter of $\frac{8}{12}$

D-

DETERMINE SHEET PILE DEPTH FOR CONTROL STRUCTURE



SOIL PROFILE TAKEN FROM BORING 80-28M

SAND LAYER IN CLAY LAYER IS IGNORED (A CONSERVATIVE ASSUMPTION)

USE PROGRAM SHTSSI (X0060)

COMPUTER INPUT

from SHEETPILE PORTION OF SSI NOTEBOOK

E_{SAND} = 5.0 pci for lower MEDIUM SAND

E_{CLAY} = 87 pci for $q = 1\text{-}2$ Tsf $q = 2c = 2\left(\frac{1500}{2000}\right) = 1.5$ Tsf

E_{CLAY} = 45 pci est. for $q = 0.6$ Tsf $q = 2\left(\frac{600}{2000}\right) = 0.6$ Tsf

I PMA 22 SHEETPILE = 22.4 in^4 / 19.625" width = 13.7 in^4/FT

A PMA 22 SHEETPILE = 10.6 in^2 / 19.625" width = 6.48 in^2/FT

PROGRAM SHT[illegible]I - SOIL-STRUCTURE INTERACTION ANALYSIS
OF CANTILEVER OR ANCHORED SHEET PILE RETAINING WALLS
DATE: 02/08/82 TIME: 12:54:12

I.--INPUT DATA

1.--HEADING

RA[illegible] PITT CREEK
N[illegible] CONTROL
CANTILEVER
[illegible]RMA 22[illegible]

2.--WALL DATA

ELEVATION AT TOP OF WALL	=	894.10	(FT)
ELEVATION AT BOTTOM OF WALL	=	~~[illegible]~~ 869.1	(FT)
WALL MODULUS OF ELASTICITY	=	29.0E+06	(PSI)
WALL MOMENT OF INERTIA	=	13.70	(IN**4)
WALL CROSS SECTION AREA	=	6.48	(SQIN)

3.--ANCHOR DATA
NONE

4.--RIGHTSIDE SOIL DATA

LAYER NO	TOP ELEV AT WALL (FT)	UNIT WEIGHT (PCF)	INTERN FRICT (DEG)	COH-HESION (PSF)	WALL FRICT (DEG)	AT-REST COEFF	SOIL MODULUS (PCI)	INTERACT DISTANCE (FT)
1	885.00	106.00	20.00	0.00	0.00	1.00	45.00	8.50
2	876.50	125.00	27.00	0.00	0.00	.80	87.00	9.50
3	867.00	130.00	30.00	0.00	0.00	.50	5.00	7.00

5.--LEFTSIDE SOIL DATA

LAYER NO	TOP ELEV AT WALL (FT)	UNIT WEIGHT (PCF)	INTERN FRICT (DEG)	COH-HESION (PSF)	WALL FRICT (DEG)	AT-REST COEFF	SOIL MODULUS (PCI)	INTERACT DISTANCE (FT)
1	886.00	106.00	20.00	0.00	0.00	1.00	45.00	9.50
2	876.50	125.00	27.00	0.00	0.00	.80	87.00	9.50
3	867.00	130.00	30.00	0.00	0.00	.50	5.00	7.00

6.--WATER DATA

WATER UNIT WEIGHT	=	62.50	(PCF)
RIGHTSIDE WATER ELEVATION	=	885.00	(FT)
LEFTSIDE WATER ELEVATION	=	889.10	(FT)

7.--SURFACE SURCHARGE LOADS
NONE

8.--HORIZONTAL LINE LOADS
NONE

9.--HORIZONTAL APPLIED PRESSURES
NONE

PROGRAM [illegible] - SOIL-STRUCTURE INTERACTION ANALYSIS
OF CANTILEVER OR ANCHORED SHEET PILE RETAINING WALLS
DATE: [illegible] TIME: 13:58:25

PAGE 3 of 4

III.--SUMMARY OF RESULTS

III.A.--HEADING
BASSETT CREEK
ML CONTROL
CANTILEVER
'PMA 22'

III.B.--MAXIMA

	MAXIMUM POSITIVE	ELEV (FT)	MAXIMUM NEGATIVE	ELEV (FT)
AXIAL DISPLACEMENT (IN) :	0.	0.00	0.	0.00
LATERAL DISPLACEMENT (IN):	2.00E-02	869.10	-4.00E+00	889.10
AXIAL FORCE (LB) :	0.	0.00	0.	0.00
SHEAR (LB) :	1.11E+03	881.00	-2.13E+03	872.55
BENDING MOMENT (LB-FT) :	8.56E+03	876.01	0.	0.00

DO YOU WANT COMPLETE RESULTS OUTPUT? ENTER 'YES' OR 'NO'.
I>Y

IV.--COMPLETE RESULTS

IV.A.--HEADING
BASSETT CREEK
ML CONTROL
CANTILEVER
'PMA 22'

IV.B.--COMPLETE RESULTS

	<----DEFLECTIONS--->		AXIAL		BENDING	SOIL
ELEV (FT)	AXIAL (IN)	LATERAL (IN)	FORCE (LB)	SHEAR (LB)	MOMENT (LB-FT)	PRESSURE (PSF)
889.10	0.	-4.00E+00	0.	0.	0.	0.00
888.10	0.	-3.67E+00	0.	32.	12.	0.00
887.10	0.	-3.34E+00	0.	127.	86.	0.00
886.10	0.	-3.01E+00	0.	282.	284.	0.00
886.00	0.	-2.97E+00	0.	300.	310.	0.00
885.10	0.	-2.68E+00	0.	510.	674.	-19.19
885.00	0.	-2.64E+00	0.	536.	721.	-21.33
884.10	0.	-2.35E+00	0.	757.	1313.	39.33
883.10	0.	-2.03E+00	0.	940.	2167.	106.72
882.10	0.	-1.72E+00	0.	1056.	3171.	174.12
881.10	0.	-1.42E+00	0.	1105.	4257.	241.51
880.10	0.	-1.14E+00	0.	1096.	5358.	308.91
879.10	0.	-8.86E-01	0.	999.	6406.	376.30
878.10	0.	-6.58E-01	0.	846.	7334.	443.70
877.10	0.	-4.62E-01	0.	624.	8074.	511.09
876.50	0.	-3.60E-01	0.	461.	8407.	551.53
876.50	0.	-3.60E-01	0.	461.	8407.	829.44
876.10	0.	-3.01E-01	0.	217.	8532.	886.62
875.10	0.	-1.77E-01	0.	-484.	8412.	1029.59
874.10	0.	-8.91E-02	0.	-1347.	7514.	1131.18
873.10	0.	-3.36E-02	0.	-1979.	5811.	643.40
872.10	0.	-3.34E-03	0.	-2099.	3720.	57.93
871.10	0.	1.07E-02	0.	-1669.	1800.	-362.82
870.10	0.	1.65E-02	0.	-928.	491.	-567.62
869.10	0.	2.00E-02	0.	0.	0.	-756.39
867.00	0.	2.00E-02	0.	0.	0.	-754.56

VERIFY ADEQUACY OF 20' LONG PMA-22 SHEETPILE.

MAXIMUM BENDING = 8560 FT-lb. /FT

$$f_b = M/S_x = \frac{8560(12)}{5.4 \text{ in}^3} = 19{,}022 \text{ psi} < 19{,}250 \text{ O.K.}$$

$$f_{ALL} = f_y/2 = \frac{38500}{2} = 19{,}250 \text{ psi}$$

MAXIMUM SHEAR = 2130 lb. /FT

ALLOWABLE SHEAR = $0.33F_y = \frac{38500}{3} = 12{,}833$ psi

$$\frac{2130}{6.48} = 329 \text{ psi} < 12{,}833 \text{ O.K.}$$

CREEP

4.1' of RETAINED HEAD.

SHEET PILE IS 30% EFFECTIVE

$$4.1/0.3 = 13.7'$$

MINIMUM PILE LENGTH = 13.7 + 4.1 = 17.8'

DEFLECTION

4" AT MAXIMUM LOAD

THE 4" DEFLECTION WOULD BE INCREASED BY REDUCUTION OF PILE LENGTH (3.95" WITH 22' PILE)

THE PLACEMENT OF RIPRAP BEHIND THE SHEETPILE WOULD REDUCE DEFLECTION

USING A CONCRETE CAP TO COVER THE TOP 5' OF THE SHEETPILE WOULD ALSO REDUCE DEFLECTION.

A MORE DETAILED INVESTIGATION OF THE DEFLECTION WILL BE DONE DURING FURTHER STAGES OF ANALYSIS.

by GLC

REFERENCE: ANALYSIS OF GROUND-LINER INTERACTION FOR TUNNELS
REPORT No. UMTA-IL-06-0043-78-3
OCTOBER 1978
PREPARED FOR U.S. DEPT OF TRANSPORTATION BY THE UNIV. OF ILLINOIS

OBTAIN EXTERIOR TUNNEL PRESSURES USING EQUATIONS PRESENTED IN THE ABOVE REFERENCE FOR NO-SLIP AND FULL-SLIP CONDITIONS ASSUMING BOTH THIN AND THICK WALL CONDUITS.

EXCAVATION LOADING - NO SLIPPAGE, THIN LINER

EXTERNAL PRESSURES ACTING ON LINER

$$P_r = \frac{\gamma H}{2}\left[(1+K_o)(1-L_n^*) - (1-K_o)\left[1 + 3J_n^* - 2N_n^*\right]\cos 2\theta\right]$$ SEC. B.3.1 PAGE 405

$$T_{r\theta} = \frac{\gamma H}{2}\left[(1-K_o)(1-3J_n^*+N_n^*)\sin 2\theta\right]$$ SEC. B.3.1 PAGE 405

$$L_n^* = \frac{(1-2\nu_m)C}{1+(1-2\nu_m)C+\frac{(1-2\nu_m)C}{6F}}$$ EQ. BOTTOM PAGE 350

$$J_n^* = \frac{[2\nu_m+(1-2\nu_m)C]F+(1-\nu_m)(1-2\nu_m)C}{[(3-2\nu_m)+(1-2\nu_m)C]F+\frac{1}{2}(5-6\nu_m)(1-2\nu_m)C+(6-8\nu_m)}$$ SEC B.3.5 PAGE 406

$$N_n^* = \frac{[3+2(1-2\nu_m)C]F+\frac{1}{2}(1-2\nu_m)C}{[(3-2\nu_m)+(1-2\nu_m)C]F+\frac{1}{2}(5-6\nu_m)(1-2\nu_m)C+(6-8\nu_m)}$$ SEC. B.3.5 PAGE 406

$$F = \left(\frac{E_m}{E_\ell}\right)\left(\frac{r}{t}\right)^3\left[\frac{2(1-\nu_\ell^2)}{(1+\nu_m)}\right]$$ EQ. A.42b PAGE 339

$$C = \left(\frac{E_m}{E_\ell}\right)\frac{r}{t}\left[\frac{(1-\nu_\ell^2)}{(1+\nu_m)(1-2\nu_m)}\right]$$ EQ. A.42a PAGE 339

EXCAVATION LOADING - FULL SLIPPAGE, THIN LINER

$$P_r = \frac{\gamma H}{2}\left[(1+K_o)(1-L_n^*) - 3(1-K_o)(1-2J_n^*)\cos 2\theta\right]$$ SEC. B.4.1 PAGE 407

L_n^* EQUATION REMAINS THE SAME.

$$J_n^*\ (J_f^*) = \frac{F+(1-\nu_m)}{2F+(5-6\nu_m)}$$ SEC. B.4.5 page 408

C AND F EQUATIONS REMAIN THE SAME

EXCAVATION LOADING - NO SLIPPAGE, THICK LINER

EXTERNAL PRESSURE ACTING ON LINER

$$P_r = \frac{\gamma H}{2}\left[(1+K_o)\left[1-L_n^*\left(\frac{R_o}{r}\right)^2\right] - (1-K_o)\left[1+3J_n^*\left(\frac{R_o}{r}\right)^4 - 4N_n^*\left(\frac{R_o}{r}\right)^2\right]\cos 2\theta\right]$$ SEC. B.7.2 PAGE 419

$$L_n^* = \frac{b_2^*}{\left(\frac{G_l}{G_m}\right)b_1^* + b_2^*} \qquad T_{r\theta} = \frac{\gamma H}{2}\left[(1-K_o)\left[1-3J_n^*\left(\frac{R_o}{R_o}\right)^4 + 2N_n^*\left(\frac{R_o}{R_o}\right)^2\right]\sin 2\theta\right]$$

$$J_n^* = \frac{\left(\frac{G_l}{G_m}\right)\left[b_{11}^* + 16\nu_m b_{12}^*\right] + b_6^*}{(3-4\nu_m)\left(\frac{G_l}{G_m}\right)^2 b_3^* + 2\left(\frac{G_l}{G_m}\right)\left[b_4^* - 2\nu_m b_5^*\right] + b_6^*}$$ SEC. B.7.3 PAGE 420

$$N_n^* = \frac{\left(\frac{G_l}{G_m}\right)b_{13}^* + b_6^*}{(3-4\nu_m)\left(\frac{G_l}{G_m}\right)^2 b_3^* + 2\left(\frac{G_l}{G_m}\right)\left[b_4^* - 2\nu_m b_5^*\right] + b_6^*}$$

$$b_1^* = \left[\left(\frac{R_o}{R_i}\right)^2 - 1\right]$$ SEC. B.7.3 PAGE 421

$$b_2^* = \left[(1-2\nu_l)\left(\frac{R_o}{R_i}\right)^2 + 1\right]$$

$$b_3^* = \left[\left(\frac{R_o}{R_i}\right)^2 - 1\right]^4$$

$$b_4^* = \left[(5-6\nu_l)\left(\frac{R_o}{R_i}\right)^6 + (5-2\nu_l)\left(\frac{R_o}{R_i}\right)^4 - (1+2\nu_l)\left(\frac{R_o}{R_i}\right)^2 + (3-2\nu_l)\right]\left[\left(\frac{R_o}{R_i}\right)^2 - 1\right]$$

$$b_5^* = \left[(3-4\nu_l)\left(\frac{R_o}{R_i}\right)^6 + 3\left(\frac{R_o}{R_i}\right)^4 - 3\left(\frac{R_o}{R_i}\right)^2 + 1\right]\left[\left(\frac{R_o}{R_i}\right)^2 - 1\right]$$

$$b_6^* = \left[(3-4\nu_l)\left(\frac{R_o}{R_i}\right)^8 + 4(3-6\nu_l+4\nu_l^2)\left(\frac{R_o}{R_i}\right)^6 - 6\left(\frac{R_o}{R_i}\right)^4 + 4\left(\frac{R_o}{R_i}\right)^2 + (3-4\nu_l)\right]$$

$$b_{11}^* = \left[\left(\frac{R_o}{R_i}\right)^6 - (11-8\nu_l)\left(\frac{R_o}{R_i}\right)^4 + (7-4\nu_l)\left(\frac{R_o}{R_i}\right)^2 + (3-4\nu_l)\right]\left[\left(\frac{R_o}{R_i}\right)^2 - 1\right]$$

SEC. 8.7.3.
PAGE 422

$$b_{12}^* = (1-\nu_l)\left[\left(\frac{R_o}{R_i}\right)^6 - \left(\frac{R_o}{R_i}\right)^4\right]$$

$$b_{13}^* = \left[\left(\frac{R_o}{R_i}\right)^6 + (1-4\nu_l)\left(\frac{R_o}{R_i}\right)^4 + (7-4\nu_l)\left(\frac{R_o}{R_i}\right)^2 + (3-4\nu_l)\right]\left[\left(\frac{R_o}{R_i}\right)^2 - 1\right]$$

EXCAVATION LOADING - FULL SLIPPAGE, THICK LINER

SEC. 8.8.2.
PAGE 424

$$P_r = \frac{\gamma H}{2}\left[(1+K_o)\left[1 - L_n^*\left(\frac{R_o}{r}\right)^2\right] - (1-K_o)\left[1 + 3J_n^*\left(\frac{R_o}{r}\right)^4 - 2N_n^*\left(\frac{R_o}{r}\right)^2\right]\cos 2\theta\right] \; ; \; T_{r\theta} = 0$$

L_n^* AND b_1^* AND b_2^* EQUATIONS REMAIN THE SAME.

$$J_n^* = \frac{2(1-\nu_m)\left(\frac{G_l}{G_m}\right)d_3^* + d_4^*}{(5-6\nu_m)\left(\frac{G_l}{G_m}\right)d_3^* + d_4^*}$$

SEC. 8.8.2.
PAGES 425, 426

$$N_n^* = \frac{\left(\frac{G_l}{G_m}\right)d_3^* + 2d_4^*}{(5-6\nu_m)\left(\frac{G_l}{G_m}\right)d_3^* + d_4^*}$$

$$d_3^* = \left[\left(\frac{R_o}{R_i}\right)^2 - 1\right]^3$$

$$d_4^* = \left[(3-2\nu_l)\left(\frac{R_o}{R_i}\right)^6 + 3(5-6\nu_l)\left(\frac{R_o}{R_i}\right)^4 + 3(3-2\nu_l)\left(\frac{R_o}{R_i}\right)^2 + (5-6\nu_l)\right]$$

LIST OF VARIABLES

γ = UNIT SOIL WEIGHT

H = HEIGHT OF FILL TO CENTER OF TUNNEL

K_o = AT REST EARTH PRESSURE COEFFICIENT

r = RADIUS OF PRESSURE SURFACE

ν_m = POISSON'S RATIO OF SOIL

ν_ℓ = POISSON'S RATIO OF LINER

E_m = MODULUS OF ELASTICITY OF SOIL

E_ℓ = MODULUS OF ELASTICITY OF LINER

R_o = OUTSIDE RADIUS OF LINER

G_ℓ = SHEAR MODULUS OF LINER

G_m = SHEAR MODULUS OF SOIL

$$G = E/2(1+\nu)$$

R_i = INSIDE RADIUS OF LINER

CONSTANTS FOR ALL CASES

$r = 70''$

$R_i = 60''$

$R_o = 70''$

$E_\ell = 3605$ KSI

$\nu_\ell = 0.17$

$G_\ell = \dfrac{3605}{2(1+.17)} = 1541$ KSI

$t = 10''$

COMPUTATIONS FOR TUNNEL SECTION 1

CONSTANTS: $V_m = 0.33$

$k_o = 0.50$

$E_m = 2.25$ KSI

$G_m = \dfrac{2.25}{2(1+0.33)} = 0.85$ KSI

$\gamma = \dfrac{14(106)+14(43.5)+16(67.5)}{44} = 72.1$ pcf

$H = 818.0 - 774.0 = 44.0'$

EXCAVATION LOADING - NO SLIPPAGE, THIN LINER

$$F = \left(\frac{2.25}{3605}\right)\left(\frac{70}{10}\right)^3\left[\frac{2(1-0.17^2)}{1+0.33}\right] = 0.3126$$

$$C = \left(\frac{2.25}{3605}\right)\left(\frac{70}{10}\right)\left[\frac{(1-0.17^2)}{(1+0.33)(1-2(0.33))}\right] = 0.0094$$

$$N_n^* = \frac{[3+2(1-2(0.33))0.0094]0.3126 + \frac{1}{2}(1-2(0.33))0.0094}{[(3-2(0.33))+(1-2(0.33))0.0094]0.3126 + \frac{1}{2}(5-6(0.33))(1-2(0.33))0.0094 + (6-8(0.33))}$$

$$N_n^* = \frac{0.9414}{4.0973} = 0.2298$$

$$J_n^* = \frac{[2(0.33)+(1-2(0.33))0.0094]0.3126 + (1-0.33)(1-2(0.33))0.0094}{[(3-2(0.33))+(1-2(0.33))0.0094]0.3126 + \frac{1}{2}(5-6(0.33))(1-2(0.33))0.0094 + (6-8(0.33))}$$

$$J_n^* = \frac{0.2095}{4.0973} = 0.0511$$

$$L_n^* = \frac{(1-2(0.33))0.0094}{1+(1-2(0.33))0.0094+\frac{(1-2(0.33))0.0094}{6(0.3126)}} = \frac{0.0032}{1.0049} = 0.0032$$

$$P_r = \left(\frac{72.1(44)}{2}\right)\left[(1+0.5)(1-0.0032)-(1-0.5)\left[1+3(0.0511)-2(0.2298)\right]\cos 2\theta\right]$$

$$P_r = 1586\left[1.4952-0.3469\cos 2\theta\right]$$

$$\tau_{r\theta} = \left(\frac{72.1(44)}{2}\right)\left[(1-0.5)(1-3(0.0511)+0.2298)\sin 2\theta\right]$$

$$\tau_{r\theta} = 853.7 \sin 2\theta$$

EXCAVATION LOADING - FULL SLIPPAGE, THIN LINER

$$J_n^* = \frac{0.3126+(1-0.33)}{2(0.3126)+(5-6(0.33))} = 0.2696$$

$$P_r = \left(\frac{72.1(44)}{2}\right)\left[(1+0.5)(1-0.0032)-3(1-0.5)(1-2(.2696))\cos 2\theta\right]$$

$$P_r = 1586\left[1.4952-0.6912\cos 2\theta\right]$$

EXCAVATION LOADING - NO SLIPPAGE, THICK LINER

$$b_{13}^* = \left[\left(\tfrac{70}{60}\right)^6+(1-4(0.17))\left(\tfrac{70}{60}\right)^4+(7-4(0.17))\left(\tfrac{70}{60}\right)^2+(3-4(0.17))\right]\left[\left(\tfrac{70}{60}\right)^2-1\right]$$

$$b_{13}^* = 5.069$$

$$b_{12}^* = (1-0.17)\left[\left(\tfrac{70}{60}\right)^6-\left(\tfrac{70}{60}\right)^4\right]$$

$$b_{12}^* = 0.5553$$

$$b_{11}^* = \left[\left(\tfrac{70}{60}\right)^6 - (11-8(0.17))\left(\tfrac{70}{60}\right)^4 + (7-4(0.17))\left(\tfrac{70}{60}\right)^2 + (3-4(0.17))\right]\left[\left(\tfrac{70}{60}\right)^2 - 1\right]$$

$$b_{11}^* = -1.595$$

$$b_6^* = \left[(3-4(0.17))\left(\tfrac{70}{60}\right)^8 + 4(3-6(0.17)+4(0.17)^2)\left(\tfrac{70}{60}\right)^6 - 6\left(\tfrac{70}{60}\right)^4 + 4\left(\tfrac{70}{60}\right)^2 + (3-4(0.17))\right]$$

$$b_6^* = 25.75$$

$$b_5^* = \left[(3-4(0.17))\left(\tfrac{70}{60}\right)^6 + 3\left(\tfrac{70}{60}\right)^4 - 3\left(\tfrac{70}{60}\right)^2 + 1\right]\left[\left(\tfrac{70}{60}\right)^2 - 1\right]$$

$$b_5^* = 3.006$$

$$b_4^* = \left[(5-6(0.17))\left(\tfrac{70}{60}\right)^6 + (5-2(0.17))\left(\tfrac{70}{60}\right)^4 - (1+2(0.17))\left(\tfrac{70}{60}\right)^2 + (3-2(0.17))\right]\left[\left(\tfrac{70}{60}\right)^2 - 1\right]$$

$$b_4^* = 7.044$$

$$b_3^* = \left[\left(\tfrac{70}{60}\right)^2 - 1\right]^4 = 0.0170$$

$$b_2^* = \left[(1-2(0.17))\left(\tfrac{70}{60}\right)^2 + 1\right] = 1.898$$

$$b_1^* = \left[\left(\tfrac{70}{60}\right)^2 - 1\right] = 0.3611$$

$$N_n^* = \frac{\left(\frac{1541}{0.85}\right)(5.069) + 25.75}{(3-4(0.33))\left(\frac{1541}{0.85}\right)^2 0.017 + 2\left(\frac{1541}{0.85}\right)\left[7.044 - 2(0.33)(3.006)\right] + 25.75}$$

$$N_n^* = 0.0821$$

$$J_n^* = \frac{\left(\frac{1541}{0.85}\right)\left[-1.595 + 16(0.33)0.5553\right] + 25.75}{(3-4(0.33))\left(\frac{1541}{0.85}\right)^2 0.017 + 2\left(\frac{1541}{0.85}\right)\left[7.044 - 2(0.33)(3.006)\right] + 25.75}$$

$$J_n^* = 0.0218$$

$$L_n^* = \frac{1.898}{\left(\frac{1541}{0.85}\right)0.3611 + 1.898} = 0.00289$$

$$P_r = \frac{72.1(44)}{2}\left[(1+0.5)\left[1-0.00289\left(\tfrac{70}{70}\right)^2\right] - (1-0.5)\left[1+3(0.0218)\left(\tfrac{70}{70}\right)^4 - 4(0.0821)\left(\tfrac{70}{70}\right)^2\right]\cos 2\theta\right]$$

$$P_r = 1586\left[1.4957 - 0.3685\cos 2\theta\right]$$

$$\tau_{r\theta} = \frac{72.1(44)}{2}\left[(1-0.5)\left[1-3(.0218)\left(\tfrac{70}{70}\right)^2 + 2(.0821)\left(\tfrac{70}{70}\right)^2\right]\sin 2\theta\right]$$

$$\tau_{r\theta} = 871.5\sin 2\theta$$

EXCAVATION LOADING - FULL SLIPPAGE, THICK LINER

$$d_4^* = \left[(3-2(0.17))\left(\tfrac{70}{60}\right)^6 + 3(5-6(0.17))\left(\tfrac{70}{60}\right)^4 + 3(3-2(0.17))\left(\tfrac{70}{60}\right)^2 + (5-6(0.17))\right]$$

$$d_4 = 43.67$$

$$d_3^* = \left[\left(\tfrac{70}{60}\right)^2 - 1\right]^3 = 0.0471$$

$$N_n^* = \frac{\left(\frac{1541}{0.85}\right)0.0471 + 2(43.67)}{(5-6(0.33))\left(\frac{1541}{0.85}\right)0.0471 + 43.67} = 0.5728$$

$$J_n^* = \frac{2(1-0.33)\left(\frac{1541}{0.85}\right)0.0471 + 43.67}{(5-6(0.33))\left(\frac{1541}{0.85}\right)0.0471 + 43.67} = 0.5243$$

$$P_r = \frac{72.1(44)}{2}\left[(1+0.5)\left[1-0.00289\left(\tfrac{70}{70}\right)^2\right] - (1-0.5)\left[1+3(0.5243)\left(\tfrac{70}{70}\right)^4 - 2(.5728)\left(\tfrac{70}{70}\right)^2\right]\cos 2\theta\right]$$

$$P_r = 1586\left[1.4957 - 0.7137\cos 2\theta\right]$$

SOIL PRESSURES – THIN WALL ASSUMPTION (psf)

	NO SLIPPAGE		FULL SLIPPAGE
$\theta°$	$P_r = 1586[1.4952 - 0.3469 \cos 2\theta]$	$\tau_{r\theta} = 853.7 \sin 2\theta$	$P_r = 1586[1.4952 - 0.6912 \cos 2\theta]$
90°	2922	0	3468
80°	2888	292	3402
70°	2793	549	3211
60°	2646	739	2920
50°	2467	841	2562
40°	2276	841	2181
30°	2096	739	1823
20°	1950	549	1532
10°	1854	292	1341
0°	1821	0	1275

SEE PAGE 10 FOR NODE CORRELATIONS, NOTES.

SOIL PRESSURES - THICK WALL ASSUMPTION (psf)

	No Slippage		Full Slippage
$\theta°$	$P_r = 1586[1.4957 - 0.3685 \cos 2\theta]$	$T_{r\theta} = 871.5 \sin 2\theta$	$P_r = 1586[1.4957 - 0.7137 \cos 2\theta]$
90°	2957	0	3504
80°	2921	298	3436
70°	2820	560	3239
60°	2664	755	2938
50°	2474	858	2569
40°	2271	858	2176
30°	2080	755	1806
20°	1924	560	1505
10°	1823	298	1309
0°	1788	0	1240

NODES	
1,19	90°
2,18	80°
3,17	70°
4,16	60°
5,15	50°
6,14	40°
7,13	30°
8,12	20°
9,11	10°
10	0°

FOR $T_{r\theta}$ (−)ANGLES PRODUCE (−)VALUES

USE THE THICK WALL EQUATIONS ONLY FOR LOAD DETERMINATION FOR THE OTHER 2 SECTIONS AS IT PRODUCED THE HIGHEST LOADING.

COMPUTATIONS FOR TUNNEL SECTION 2

CONSTANTS

$\nu_m = 0.44$

$K_o = 0.80$

$E_m = 0.9 \text{ KSI}$

$G_m = \frac{0.9}{2(1+0.44)} = 0.31 \text{ KSI}$

$H = 822.0 - 772.62 = 49.38'$ say $50.0'$ TO ACCOUNT FOR GROUND IRREGULARITIES

$\gamma = \frac{10(106) + 10(130) + 5(62.5) + 25(62.5)}{50} = 85.2 \text{ pcf}$

EXCAVATION LOADING, NO SLIPPAGE, THICK WALL

SEE SECTION 1 COMPUTATIONS FOR VALUES FOR : $b_{13}^*, b_{12}^*, b_{11}^*, b_6^*, b_5^*, b_4^*, b_3^*, b_2^*$, AND b_1^*

$$N_n^* = \frac{\left(\frac{1541}{0.31}\right)5.069 + 25.75}{(3-4(0.44))\left(\frac{1541}{0.31}\right)^2 0.017 + 2\left(\frac{1541}{0.31}\right)\left[7.044 - 2(0.44)(3.006)\right] + 25.75}$$

$$N_n^* = 0.0447$$

$$J_n^* = \frac{\left(\frac{1541}{0.31}\right)\left[-1.595 + 16(0.44)(0.5553)\right] + 25.75}{(3-4(0.44))\left(\frac{1541}{0.31}\right)^2 0.017 + 2\left(\frac{1541}{0.31}\right)\left[7.044 - 2(0.44)(3.006)\right] + 25.75}$$

$$J_n^* = 0.0204$$

$$L_n^* = \frac{1.898}{\left(\frac{1541}{0.31}\right)0.3611 + 1.898}$$

$$L_n^* = 0.00106$$

$$P_r = \frac{(85.2)(50)}{2}\left[(1+0.8)\left[1-(0.00106)\left(\frac{70}{70}\right)^2\right]-(1-0.8)\left[1+3(0.0204)\left(\frac{70}{70}\right)^4-4(0.0447)\left(\frac{70}{70}\right)^2\right]\cos 2\theta\right]$$

$$P_r = 2130\left[1.7981 - 0.1765 \cos 2\theta\right]$$

$$\tau_r = \frac{85.2(50)}{2}\left[(1-0.8)\left[1-3(0.0204)\left(\frac{70}{70}\right)^4+2(0.0447)\left(\frac{70}{70}\right)^2\right]\sin 2\theta\right.$$

$$\tau_r = 438.0 \sin 2\theta$$

EXCAVATION LOADING, FULL SLIPPAGE, THICK WALL

$$d_4^* = \left[(3-2(0.17))\left(\frac{70}{60}\right)^6+3(5-6(0.17))\left(\frac{70}{60}\right)^4+3(3-2(0.17))\left(\frac{70}{60}\right)^2+(5-6(0.17))\right]$$

$$d_4^* = 43.67$$

$$d_3^* = \left[\left(\frac{70}{60}\right)^2-1\right]^3 = 0.0471$$

$$N_n^* = \frac{\left(\frac{1541}{0.31}\right)0.0471+2(43.67)}{(5-6(0.44))\left(\frac{1541}{0.31}\right)(0.0471)+43.67} = 0.5329$$

$$J_n^* = \frac{2(1-0.44)\left(\frac{1541}{0.31}\right)(0.0471)+43.67}{(5-6(0.44))\left(\frac{1541}{0.31}\right)(0.0471)+43.67} = 0.5131$$

$L_n^* = 0.00106$ (SEE PAGE 11 OF THESE COMPUTATIONS)

$$P_r = \frac{85.2(50)}{2}\left[(1+0.8)\left[1-.00106\left(\frac{70}{70}\right)^2\right]-(1-0.8)\left[1+3(0.5131)\left(\frac{70}{70}\right)^4-2(0.5329)\left(\frac{70}{70}\right)^2\right]\cos 2\theta\right]$$

$$P_r = 2130\left[1.7981 - 0.2947 \cos 2\theta\right]$$

SOIL PRESSURES - THICK WALL ASSUMPTION (psf)

		NO SLIPPAGE		FULL SLIPPAGE
θ	NODE	$P_r = 2130[1.7981 - 0.1765 \cos 2\theta]$	$\tau_{r\theta} = 438.0 \sin 2\theta$ *	$P_r = 2130[1.7981 - 0.2947 \cos 2\theta]$
90°	1,19	4206	0	4458
80°	2,18	4183	150	4420
70°	3,17	4118	282	4311
60°	4,16	4018	379	4144
50°	5,15	3895	431	3939
40°	6,14	3765	431	3721
30°	7,13	3642	379	3516
20°	8,12	3542	282	3349
10°	9,11	3477	150	3240
0°	10	3454	0	3202

* FOR $\tau_{r\theta}$ NEG. ANGLES PRODUCE NEG. VALUES

COMPUTATIONS FOR TUNNEL SECTION 3

CONSTANTS

$\nu_m = 0.44$

$k_o = 0.80$

$E_m = 0.9$ KSI

$G_m = 0.31$ KSI

$H = 848 - 770.09 = 77.91'$ use $78.0'$

$\gamma = \frac{33(130)+45(125)}{78} = 91.1$ pcf

EXCAVATION LOADING, NO SLIPPAGE, THICK WALL

SEE SECTION 1 COMPUTATIONS FOR VALUES OF: $b_{13}^*, b_{12}^*, b_{11}^*, b_6^*, b_5^*, b_4^*, b_3^*, b_2^*$, AND b_1^*.

SEE SECTION 2 COMPUTATIONS FOR VALUES OF N_n^*, J_n^*, AND L_n^*.

$$P_r = \frac{91.1(78)}{2}\left[1.7981 - 0.1765 \cos 2\theta\right]$$

$$P_r = 3553\left[1.7981 - 0.1765 \cos 2\theta\right]$$

$$T_{r\theta} = \frac{91.1(78)}{2}\left[(1-0.8)\left[1-3(0.0204)\left(\tfrac{70}{70}\right)^4+2(0.0447)\left(\tfrac{70}{70}\right)^2\right]\right]\sin 2\theta$$

$$T_{r\theta} = 730.6 \sin 2\theta$$

EXCAVATION LOADING, FULL SLIPPAGE, THICK WALL

SEE SECTION 1 COMPUTATIONS OF VALUES FOR: $b_{13}^*, b_{12}^*, b_{11}^*, b_6^*, b_5^*, b_4^*, b_3^*, b_2^*$, AND b_1^*.

SEE SECTION 2 COMPUTATIONS OF VALUES FOR: N_n^*, J_n^*, AND L_n^*.

$$P_r = \frac{91.1(78)}{2}\left[1.7981 - 0.2947 \cos 2\theta\right]$$

$$P_r = 3553\left[1.7981 - 0.2947 \cos 2\theta\right]$$

BASSETT CREEK TUNNEL — FEB. 1982 — SPL

TUNNEL DESIGN

✓'d by GLC

SOIL PRESSURES - THICK WALL ASSUMPTION (psf)

		No Slippage		Full Slippage
θ	Node	$P_r = 3553[1.7981 - 0.1765\cos 2\theta]$	$T_{r\theta} = 730.6 \sin 2\theta$ *	$P_r = 3553[1.7981 - 0.2947\cos 2\theta]$
90°	1,19	7016	0	7436
80°	2,18	6979	250	7373
70°	3,17	6869	470	7191
60°	4,16	6702	633	6912
50°	5,15	6498	720	6570
40°	6,14	6280	720	6207
30°	7,13	6075	633	5865
20°	8,12	5908	470	5587
10°	9,11	5799	250	5405
0°	10	5762	0	5342

* FOR $T_{r\theta}$ NEG. ANGLES PRODUCE NEG. VALUES

NEWTON INPUT, SECTION 1

2 LOADING CONDITIONS : 1- NO WATER IN TUNNEL, WATER OUTSIDE TUNNEL
2- MAXIMUM INTERNAL HEAD IN TUNNEL, WATER OUTSIDE TUNNEL

MAXIMUM INTERIOR HEAD $= \left[(818.9-804.1)\left(\frac{5940-2680}{6700-2680}\right)\right] + 804.1 = 816.1$

WATER TABLE ELEV. 804.0

USE FULL SLIPPAGE ASSUMPTION AS ASSUMED WORST LOADING CONDITION.

$F_i = \left[(h_i - R_i) - \cos\theta R_i\right] S_i \gamma_w$; $S_i = \frac{\pi 2R_i}{18} = \frac{\pi 2(5)}{18} = 1.745$

$F_E = \left[(h_e - R_e) - \sin\theta R_e\right] S_e \gamma_w$; $S_e = \frac{\pi 2R_e}{18} = \frac{\pi 2(5.833)}{18} = 2.036$

$F_R = S_e(P_r)$

$F_n = F_R + F_E - F_i$; $F_x = \cos\theta F_n$, $F_y = \sin\theta F_n$

LINING WEIGHT PER 10° SEGMENT OF TUNNEL

$$\frac{\pi(R_e^2 - R_i^2)150}{36} = \frac{\pi\left(\frac{70^2-60^2}{12^2}\right)150}{36} = 118 \text{ lb.}$$

LOAD CASE 1 - SOIL + LINER + EXTERIOR WATER, FULL SLIPPAGE (SEE PAGE 10 THESE COMPUTATIONS FOR P_r)

$F_E = \left[((807.0-774.0) - 5833\sin\theta\right] 2.036(62.5) = 4199 - 742.2\sin\theta$

$F_R = 2.036\,(P_r)$

NODE 19, $\theta = 90°$ (IN POUNDS)

$F_n = 2.036(3504) + (4199 - 742.2\sin 90°) = 10{,}591$

$F_x = F_n\cos\theta = F_n\cos 90° = 0$

$F_y = F_n\sin\theta + 118 = 10591(\sin 90°) + 118 = 10709 \downarrow$

NODE 18, $\theta = 80^\circ$

$F_n = 2.036\,(3436) + (4199 - 742.2 \sin 80^\circ) = 10{,}464$

$F_x = 10{,}464 \cos 80^\circ = 1817 \leftarrow$

$F_y = 10{,}464 \sin 80^\circ + 118 = 10423 \downarrow$

NODE 17, $\theta = 70^\circ$

$F_n = 2.036\,(3239) + (4199 - 742.2 \sin 70^\circ) = 10{,}096$

$F_x = 10096 \cos 70^\circ = 3453 \leftarrow$

$F_y = 10096 \sin 70^\circ + 118 = 9605 \downarrow$

NODE 16, $\theta = 60^\circ$

$F_n = 2.036\,(2938) + (4199 - 742.2 \sin 60^\circ) = 9{,}538$

$F_x = 9538 \cos 60^\circ = 4769 \leftarrow$

$F_y = 9538 \sin 60^\circ + 118 = 8378 \downarrow$

NODE 15, $\theta = 50^\circ$

$F_n = 2.036\,(2569) + (4199 - 742.2 \sin 50^\circ) = 8861$

$F_x = 8861 \cos 50^\circ = 5696 \leftarrow$

$F_y = 8861 \sin 50^\circ + 118 = 6906 \downarrow$

NODE 14, $\theta = 40^\circ$

$F_n = 2.036\,(2176) + (4199 - 742.2 \sin 40^\circ) = 8152$

$F_x = 8152 \cos 40^\circ = 6245 \leftarrow$

$F_y = 8152 \sin 40^\circ + 118 = 5358 \downarrow$

NODE 13, $\theta = 30^\circ$

$F_n = 2.036\,(1806) + (4199 - 742.2 \sin 30^\circ) = 7505$

$F_x = 7505 \cos 30^\circ = 6499 \leftarrow$

$F_y = 7505 \sin 30^\circ + 118 = 3870 \downarrow$

NODE 12, $\theta = 20°$

$F_n = 2.036(1505) + (4199 - 742.2 \sin 20°) = 7009$

$F_x = 7009 \cos 20° = 6587 \leftarrow$

$F_y = 7009 \sin 20° + 118 = 2515 \downarrow$

NODE 11, $\theta = 10°$

$F_n = 2.036(1309) + (4199 - 742.2 \sin 10°) = 6735$

$F_x = 6735 \cos 10° = 6663 \leftarrow$

$F_y = 6735 \sin 10° + 118 = 1288 \downarrow$

NODE 10, $\theta = 0°$

$F_n = 2.036(1240) + (4199 - 742.2 \sin 0°) = 6724$

$F_x = 6724 \cos 0° = 6724 \leftarrow$

$F_y = 6724 \sin 0° + 118 = 118 \downarrow$

NODE 9, $\theta = -10°$

$F_n = 2.036(1309) + (4199 - 742.2 \sin -10°) = 6993$

$F_x = 6993 \cos -10° = 6887 \leftarrow$

$F_y = 6993 \sin -10° + 118 = 1096 \uparrow$

NODE 8, $\theta = -20°$

$F_n = 2.036(1505) + (4199 - 742.2 \sin -20°) = 7517$

$F_x = 7517 \cos -20° = 7064 \leftarrow$

$F_y = 7517 \sin -20° + 118 = 2453 \uparrow$

NODE 7, $\theta = -30°$

$F_n = 2.036(1806) + (4199 - 742.2 \sin -30°) = 8247$

$F_x = 8247 \cos -30° = 7142 \leftarrow$

$F_y = 8247 \sin -30° + 118 = 4006 \uparrow$

NODE 6, $\theta = -40°$

$F_n = 2.036(2176) + (4199 - 742.2 \sin -40°) = 9106$

$F_x = 9106 \cos -40° = 6976 \leftarrow$

$F_y = 9106 \sin -40° + 118 = 5735 \uparrow$

NODE 5, $\theta = -50°$

$F_n = 2.036(2569) + (4199 - 742.2 \sin -50°) = 9998$

$F_x = 9998 \cos -50° = 6427 \leftarrow$

$F_y = 9998 \sin -50° + 118 = 7541 \uparrow$

NODE 4, $\theta = -60°$

$F_n = 2.036(2938) + (4199 - 742.2 \sin -60°) = 10824$

$F_x = 10824 \cos -60° = 5412 \leftarrow$

$F_y = 10824 \sin -60° + 118 = 9255 \uparrow$

NODE 3, $\theta = -70°$

$F_n = 2.036(3239) + (4199 - 742.2 \sin -70°) = 11491$

$F_x = 11491 \cos -70° = 3930 \leftarrow$

$F_y = 11491 \sin -70° + 118 = 10680 \uparrow$

NODE 2, $\theta = -80°$

$F_n = 2.036(3436) + (4199 - 742.2 \sin -80°) = 11926$

$F_x = 11926 \cos -80° = 2071 \leftarrow$

$F_y = 11926 \sin -80° + 118 = 11626 \uparrow$

NODE 1, $\theta = -90°$

$F_n = 2.036(3504) + (4199 - 742.2 \sin -90°) = 12075$

$F_x = 12075 \cos -90° = 0$

$F_y = 12075 \sin -90° + 118 = 11957 \uparrow$

LOAD CASE 2 - SOIL + LINER + EXTERIOR WATER + INTERIOR WATER, FULL SLIPPAGE

$F_i = [(816.1 - 774.0) - 5\sin\theta]\, 62.5(1.745) = 4592 - 545.3\sin\theta$

$F_n = P_r\, 2.036 + (4199 - 742.2\sin\theta) - (4592 - 545.3\sin\theta)$

$F_n = 2.036 P_r - 393 - 196.9\sin\theta$

NODE 19, $\theta = 90°$

$F_n = 2.036(3504) - 393 - 196.9\sin 90° = 6544$

$F_x = F_n\cos\theta = 6544\cos 90° = 0$

$F_y = F_n\sin 90° + 118 = 6544\sin 90° + 118 = 6662 \downarrow$

NODE 18, $\theta = 80°$

$F_n = 2.036(3436) - 393 - 196.9\sin 80° = 6409$

$F_x = 6409\cos 80° = 1113 \leftarrow$

$F_y = 6409\sin 80° + 118 = 6429 \downarrow$

NODE 17, $\theta = 70°$

$F_n = 2.036(3239) - 393 - 196.9\sin 70° = 6017$

$F_x = 6017\cos 70° = 2058 \leftarrow$

$F_y = 6017\sin 70° + 118 = 5772 \downarrow$

NODE 16, $\theta = 60°$

$F_n = 2.036(2938) - 393 - 196.9\sin 60° = 5418$

$F_x = 5418\cos 60° = 2709 \leftarrow$

$F_y = 5418\sin 60° + 118 = 4810 \downarrow$

NODE 15, $\theta = 50°$

$F_n = 2.036(2569) - 393 - 196.9\sin 50° = 4687$

$F_x = 4687\cos 50° = 3013 \leftarrow$

$F_y = 4687\sin 50° + 118 = 3708 \downarrow$

NODE 14, $\theta = 40^\circ$

$F_n = 2.036(2176) - 393 - 196.9 \sin 40^\circ = 3911$

$F_x = 3911 \cos 40^\circ = 2996 \leftarrow$

$F_y = 3911 \sin 40^\circ + 118 = 2632 \downarrow$

NODE 13, $\theta = 30^\circ$

$F_n = 2.036(1806) - 393 - 196.9 \sin 30^\circ = 3186$

$F_x = 3186 \cos 30^\circ = 2759 \leftarrow$

$F_y = 3186 \sin 30^\circ + 118 = 1711 \downarrow$

NODE 12, $\theta = 20^\circ$

$F_n = 2.036(1505) - 393 - 196.9 \sin 20^\circ = 2604$

$F_x = 2604 \cos 20^\circ = 2447 \leftarrow$

$F_y = 2604 \sin 20^\circ + 118 = 1009 \downarrow$

NODE 11, $\theta = 10^\circ$

$F_n = 2.036(1309) - 393 - 196.9 \sin 10^\circ = 2238$

$F_x = 2238 \cos 10^\circ = 2204 \leftarrow$

$F_y = 2238 \sin 10^\circ + 118 = 507 \downarrow$

NODE 10, $\theta = 0^\circ$

$F_n = 2.036(1240) - 393 - 196.9 \sin 0^\circ = 2132$

$F_x = 2132 \cos 0^\circ = 2132 \leftarrow$

$F_y = 118 \downarrow$

NODE 9, $\theta = -10^\circ$

$F_n = 2.036(1309) - 393 - 196.9 \sin -10^\circ = 2306$

$F_x = 2306 \cos 10^\circ = 2272 \leftarrow$

$F_y = 2306 \sin 10^\circ + 118 = 282 \uparrow$

NODE 8, $\theta = -20^\circ$

$F_n = 2.036(1505) - 393 - 196.9 \sin -20^\circ = 2739$

$F_x = 2739 \cos -20^\circ = 2573 \leftarrow$

$F_y = 2739 \sin -20^\circ + 118 = 819 \uparrow$

NODE 7, $\theta = -30°$

$F_n = 2.036(1806) - 393 - 196.9 \sin -30° = 3382$

$F_x = 3382 \cos -30° = 2929 \leftarrow$

$F_y = 3382 \sin -30° + 118 = 1573 \uparrow$

NODE 6, $\theta = -40°$

$F_n = 2.036(2176) - 393 - 196.9 \sin -40° = 4164$

$F_x = 4164 \cos -40° = 3190 \leftarrow$

$F_y = 4164 \sin -40° + 118 = 2559 \uparrow$

NODE 5, $\theta = -50°$

$F_n = 2.036(2569) - 393 - 196.9 \sin -50° = 4988$

$F_x = 4988 \cos -50° = 3206 \leftarrow$

$F_y = 4988 \sin -50° + 118 = 3703 \uparrow$

NODE 4, $\theta = -60°$

$F_n = 2.036(2938) - 393 - 196.9 \sin -60° = 5759$

$F_x = 5759 \cos -60° = 2880 \leftarrow$

$F_y = 5759 \sin -60° + 118 = 4870 \uparrow$

NODE 3, $\theta = -70°$

$F_n = 2.036(3239) - 393 - 196.9 \sin -70° = 6387$

$F_x = 6387 \cos -70° = 2184 \leftarrow$

$F_y = 6387 \sin -70° + 118 = 5883 \uparrow$

NODE 2, $\theta = -80°$

$F_n = 2.036(3436) - 393 - 196.9 \sin -80° = 6797$

$F_x = 6797 \cos -80° = 1180 \leftarrow$

$F_y = 6797 \sin -80° + 118 = 6575 \uparrow$

NODE 1, $\theta = -90°$

$F_n = 2.036(3504) - 393 - 196.9 \sin -90° = 6938$

$F_x = 6938 \cos -90° = 0$

$F_y = 6938 \sin -90° + 118 = 6820 \uparrow$

DATA FILE BTUN 1

```
100 BA[illegible]ETT CREEK TUNNEL
101 10 INCH CONCRETE LINER, 10 FOOT DIAMETER
102 PERVIOUS SECTION
104 19,18,2
110 1,101,0,0,0,0,0
111 2,0,11.2,0.98,0,0,0
112 3,0,22.06,3.89,0,0,0
113 4,0,32.25,8.64,0,0,0
114 5,0,41.46,15.09,0,0,0
115 6,0,49.41,23.04,0,0,0
116 7,0,55.86,32.25,0,0,0
117 8,0,60.61,42.44,0,0,0
118 9,0,63.52,53.3,0,0,0
119 10,0,64.5,64.5,0,0,0
120 11,0,63.52,75.7,0,0,0
121 12,0,60.61,86.56,0,0,0
122 13,0,55.86,96.75,0,0,0
123 14,0,49.41,105.96,0,0,0
124 15,0,41.46,113.91,0,0,0
125 16,0,32.25,120.36,0,0,0
126 17,0,22.06,125.11,0,0,0
127 18,0,11.2,128.02,0,0,0
128 19,[illegible],0,129.,0
130 1 1 2 120. 3605000. 2250. 1000. 0 0 0
131 18 18 19 120. 3605000. 2250. 1000. 0 0 0
200 LC 1 SOIL,EXWATER,LINER
201 19,0
202 1,0,11957,0
203 2,-2071,11626,0
204 3,-3930,10680,0
205 4,-5412,9255,0
206 5,-6427,7541,0
207 6,-6976,5735,0
208 7,-7142,4006,0
209 8,-6724,2453,0
210 9,-6887,1096,0
211 10,-6724,-118,0
212 11,-6633,-1288,0
213 12,-6587,-2515,0
214 13,-6499,-3870,0
215 14,-6245,-5358,0
216 15,-5696,-6906,0
217 16,-4769,-8378,0
218 17,-3453,-9605,0
219 18,-1817,-10423,0
220 19,0,-10709,0
221 0,0,0,0,0
```

```
300 LC 2 SOIL,IHEXWATER,LINER
301 19,0
302 1,0,6820,0
303 2,-1180,6575,0
304 3,-2184,5883,0
305 4,-2880,4870,0
306 5,-3206,3703,0
307 6,-3190,2559,0
308 7,-2929,1573,0
309 8,-2573,819,0
310 9,-2272,282,0
311 10,-2132,-118,0
312 11,-2204,-507,0
313 12,-2447,-1009,0
314 13,-2759,-1711,0
315 14,-2992,-2632,0
316 15,-3013,-3708,0
317 16,-2709,-4810,0
318 17,-2058,-5772,0
319 18,-1113,-6429,0
320 19,0,-6662,0
321 0,0,0,0,0
400 $END
```

** NEWTUN ** ANALYSIS OF CAST IN PLACE TUNNELS

BASSETT CREEK TUNNEL
10 INCH CONCRETE LINER
PERVIOUS SECTION

NUMBER OF NODES = 19
NUMBER OF ELEMENTS = 18
NUMBER OF LOADINGS = 2

(RESTRAINT CODE =1 SPECIFY RESTRAINT, =0 SPECIFY LOAD)

NODE	RESTRAINT CODE	X-COOR	Y-COOR	SPECIFIED DISPLACEMENTS X	Y	ROT
1	101	0.00	0.00	0.00	0.00	0.00
2	0	11.20	.98	0.00	0.00	0.00
3	0	22.06	3.89	0.00	0.00	0.00
4	0	32.25	8.64	0.00	0.00	0.00
5	0	41.46	15.09	0.00	0.00	0.00
6	0	49.41	23.04	0.00	0.00	0.00
7	0	55.86	32.25	0.00	0.00	0.00
8	0	60.61	42.44	0.00	0.00	0.00
9	0	63.52	53.30	0.00	0.00	0.00
10	0	64.50	64.50	0.00	0.00	0.00
11	0	63.52	75.70	0.00	0.00	0.00
12	0	60.61	86.56	0.00	0.00	0.00
13	0	55.86	96.75	0.00	0.00	0.00
14	0	49.41	105.96	0.00	0.00	0.00
15	0	41.46	113.91	0.00	0.00	0.00
16	0	32.25	120.36	0.00	0.00	0.00
17	0	22.06	125.11	0.00	0.00	0.00
18	0	11.20	128.02	0.00	0.00	0.00
19	101	0.00	129.00	0.00	0.00	0.00

LC 1 OIL+EXWATER+LINER

NUMBER OF NODAL POINT LOAD CARDS = 19

SPECIFIED NODAL POINT LOADS

NODE	FX	FY	MOM
1	0.000	11957.000	0.000
2	-2071.000	11626.000	0.000
3	-3930.000	10680.000	0.000
4	-5412.000	9255.000	0.000
5	-6427.000	7541.000	0.000
6	-6976.000	5735.000	0.000
7	-7142.000	4006.000	0.000
8	-6724.000	2453.000	0.000
9	-6887.000	1096.000	0.000
10	-6724.000	-118.000	0.000
11	-6633.000	-1288.000	0.000
12	-6587.000	-2515.000	0.000
13	-6499.000	-3870.000	0.000
14	-6245.000	-5358.000	0.000
15	-5696.000	-6906.000	0.000
16	-4769.000	-8378.000	0.000
17	-3453.000	-9605.000	0.000
18	-1817.000	-10423.000	0.000
19	0.000	-10709.000	0.000

NODAL POINT DISPLACEMENTS

LC 1

NODE	X-DISPL	Y-DISPL	ROT-DISPL
1	0.	.24049E+00	0.
2	-.85113E-03	.23355E+00	-.11745E-02
3	.25021E-02	.21529E+00	-.20655E-02
4	.12377E-01	.19048E+00	-.26164E-02
5	.28753E-01	.16434E+00	-.28003E-02
6	.49406E-01	.14140E+00	-.26266E-02
7	.70634E-01	.12450E+00	-.21444E-02
8	.88330E-01	.11439E+00	-.14395E-02
9	.99118E-01	.10974E+00	-.61735E-03
10	.10115E+00	.10786E+00	.22465E-03
11	.94312E-01	.10557E+00	.10065E-02
12	.80119E-01	.10003E+00	.16619E-02
13	.61284E-01	.89444E-01	.21369E-02
14	.41169E-01	.73385E-01	.23942E-02
15	.23019E-01	.53009E-01	.24090E-02
16	.93756E-02	.30837E-01	.21708E-02
17	.14972E-02	.10364E-01	.16808E-02
18	-.96040E-03	-.45161E-02	.95017E-03
19	0.	-.10156E-01	0.

END ACTIONS WITH NODAL POINT LOADS

LC 1

ELEMENT	AXIAL I AXIAL J	SHEAR I SHEAR J	MOMENT I MOMENT J
1	55891.234	7112.203	416597.478
	-55891.234	-7112.203	-336636.455
2	57285.826	9064.889	336636.455
	-57285.826	-9064.889	-234718.838
3	58940.013	10328.167	234718.838
	-58940.013	-10328.167	-118602.219
4	60714.080	10608.986	118602.219
	-60714.080	-10608.986	684.779
5	62421.653	9786.678	-684.779
	-62421.653	-9786.678	110716.376
6	63868.715	7807.521	-110716.376
	-63868.715	-7807.521	198503.813
7	64866.869	4750.225	-198503.813
	-64866.869	-5312.652	254588.713
8	65433.851	1106.849	-254588.713
	-65433.851	-2682.716	275616.179
9	65397.167	-1763.858	-275616.179
	-65397.167	-539.553	268682.135
10	64965.646	-4117.501	-268682.135
	-64965.646	1400.868	237827.776
11	64208.153	-5920.086	-237827.776
	-64208.153	3100.428	187478.086
12	63199.781	-7161.300	-187478.086
	-63199.781	4516.559	122344.116
13	62010.188	-7892.275	-122344.116
	-62010.188	5643.180	46858.182
14	60716.685	-8116.078	-46858.182
	-60716.685	6411.267	-34160.606
15	59386.357	-7928.342	34160.606
	-59386.357	6830.170	-116515.476
16	58077.228	-7442.610	116515.476
	-58077.228	6923.804	-196754.427
17	56844.307	-6724.290	196754.427
	-56844.307	6645.730	-271653.201
18	55728.322	-5873.689	271653.201
	-55728.322	5873.689	-337689.873

LC 2 SOIL+THERMATER+LINER

NUMBER OF NODAL POINT LOAD CARDS = 19

SPECIFIED NODAL POINT LOADS

NODE	FX	FY	MOM
1	0.000	6820.000	0.000
2	-1180.000	6575.000	0.000
3	-2184.000	5883.000	0.000
4	-2880.000	4870.000	0.000
5	-3206.000	3703.000	0.000
6	-3190.000	2559.000	0.000
7	-2929.000	1573.000	0.000
8	-2573.000	819.000	0.000
9	-2272.000	282.000	0.000
10	-2132.000	-118.000	0.000
11	-2204.000	-507.000	0.000
12	-2447.000	-1009.000	0.000
13	-2759.000	-1711.000	0.000
14	-2992.000	-2632.000	0.000
15	-3013.000	-3708.000	0.000
16	-2709.000	-4810.000	0.000
17	-2058.000	-5772.000	0.000
18	-1113.000	-6429.000	0.000
19	0.000	-6662.000	0.000

NODAL POINT DISPLACEMENTS

LC 2

NODE	X-DISPL	Y-DISPL	ROT-DISPL
1	0.	.92536E-01	0.
2	-.29083E-03	.87529E-01	-.85717E-03
3	.25100E-02	.74180E-01	-.15296E-02
4	.10208E-01	.55821E-01	-.19665E-02
5	.22937E-01	.36231E-01	-.21420E-02
6	.39213E-01	.18763E-01	-.20618E-02
7	.56468E-01	.56179E-02	-.17598E-02
8	.71720E-01	-.24716E-02	-.12819E-02
9	.82231E-01	-.62215E-02	-.68091E-03
10	.86081E-01	-.74686E-02	-.14836E-04
11	.82549E-01	-.86853E-02	.65501E-03
12	.72265E-01	-.12366E-01	.12664E-02
13	.57095E-01	-.20404E-01	.17587E-02
14	.39772E-01	-.33574E-01	.20748E-02
15	.23337E-01	-.51167E-01	.21633E-02
16	.10442E-01	-.70944E-01	.19883E-02
17	.26208E-02	-.89489E-01	.15462E-02
18	-.25075E-03	-.10297E+00	.86558E-03
19	0.	-.10802E+00	0.

LC 2

END ACTIONS WITH NODAL POINT LOADS

ELEMENT	AXIAL I / AXIAL J	SHEAR I / SHEAR J	MOMENT I / MOMENT J
1	27942.979	4401.047	299592.039
	-27942.979	-4401.047	-250111.973
2	28844.682	6138.447	250111.973
	-28844.682	-6138.447	-181096.685
3	29978.293	7295.401	181096.685
	-29978.293	-7295.401	-99076.586
4	31224.718	7613.428	99076.586
	-31224.718	-7613.428	-13471.516
5	32423.670	6963.592	13471.516
	-32423.670	-7075.853	65077.475
6	33425.862	5421.572	-65077.475
	-33425.862	-6243.198	130141.874
7	34190.462	3656.050	-130141.874
	-34190.462	-5120.077	179066.336
8	34685.386	1807.361	-179066.336
	-34685.386	-3730.956	209936.229
9	34889.206	-60.669	-209936.229
	-34889.206	-2090.946	221255.592
10	34790.449	-1865.877	-221255.592
	-34790.449	-256.930	212297.090
11	34387.275	-3527.976	-212297.090
	-34387.275	1690.958	183216.961
12	33691.626	-4987.643	-183216.961
	-33691.626	3668.136	134966.756
13	32721.966	-6228.458	-134966.756
	-32721.966	5608.978	68933.307
14	31506.304	-7226.628	-68933.307
	-31506.304	7216.277	-12206.519
15	30116.462	-7809.668	12206.519
	-30116.462	7809.668	-100018.104
16	28723.158	-7422.600	100018.104
	-28723.158	7422.600	-183468.273
17	27493.538	-6185.770	183468.273
	-27493.538	6185.770	-253015.613
18	26550.124	-4364.318	253015.613
	-26550.124	4364.318	-302082.743

◆◆◆ $END ◆◆◆

CHECK ASSUMED 10" CONCRETE THICKNESS FOR STRUCTURAL ADEQUACY.

MAX. SHEAR LC 1 AT NODE 4 10,609 lb., A = 60,714

MAX MOMENT LC 1 AT NODE 1 M = 416,597 in-lb
A = 55,891 lb.

LC 2 AT NODE 19 M = 302,083 in-lb
A = 26,550 lb.

USE WORKING STRESS METHOD REF. EM 1110-2-2902 AND REINFORCED CONCRETE DESIGN HANDBOOK WORKING STRESS METHOD ACI SP-3.

CHECK SHEAR AND DIAGONAL TENSION WITH 10" THICKNESS

$$f_t = \frac{f_c}{2} - \sqrt{\left(\frac{f_c}{2}\right)^2 + v^2} \leq 2\sqrt{f'_c}$$

$$f_c = \frac{60714}{10(12)} = 506.0 \text{ psi}$$

$$v = \frac{10609}{8(12)} = 110.5 \text{ psi}$$

$$f_t = \frac{506.0}{2} - \sqrt{\left(\frac{506.0}{2}\right)^2 + (110.5)^2} = -23.1 \text{ psi} \leq 2\sqrt{f'_c} \text{ O.K.}$$

CHECK THICKNESS REQUIRED FOR REINFORCING.

M = 416,597 in-lb WITH AXIAL OF 55,891 lb.

$f_c = 0.45(4000) = 1800$ psi

$f_s = 20,000$ psi

$$n = \frac{29000000}{57000\sqrt{4000}} = 8.04$$

$d = 8"$, $d'' = 3"$, $b = 12"$

$$e = \frac{M}{N} + d'' = \frac{416597}{55891} + 3 = 10.45"$$

DETERMINE DEPTH OF CONCRETE REQUIRED WITHOUT COMPRESSION REINFORCEMENT.

$$E = \frac{10.45}{12} = 0.8711$$

$$NE = 55.6(0.8711) = 48.4$$

$K = 324$

$KF \geq NE$

$F \geq NE/K = \frac{48.4}{324} = 0.1494$

from TABLE 4. $d_{REQ} = 12\frac{1}{2}''$ $F = 0.156$

DETERMINE DEPTH OF CONCRETE REQUIRED WITH COMPRESSION REINFORCEMENT, $h = 12''$, $d = 9.5''$

$d'/d = 2.5/9.5 = 0.2632$

$$c = \frac{20000\,(2(8.04)-1)(1-0.2632)(0.419-0.2632)}{12000\,(8.04)(1-0.419)} = 0.618$$

$$A'_s = \frac{NE-KF}{cd} = \frac{48.4-324(.090)}{0.618(9.5)} = 3.28$$ ← FROM TABLE 4, $d = 9.5''$ TOO MUCH STEEL

TRY $h = 14''$, $d = 11.5''$

$d'/d = 2.5/11.5 = 0.2174$

$$c = \frac{20000}{12000}\left[1 - \frac{1800}{20000}\left(\frac{0.42(11.5)-2.5}{0.42(11.5)}\right)\right](1-0.2174) = 1.25$$

$$A'_s = \frac{48.4 - 324(0.132)}{1.25(11.5)} = 0.39\ \text{in}^2/\text{FT}$$

$$A_s = \frac{NE}{adi} = \frac{48.4}{1.44(11.5)(5.10)}$$ $j = 0.860$ $e/d = \frac{12.27}{11.5} = 1.07$

$A_s = 0.57\ \text{in}^2$ $i = 1/(1-j/e) = 1/(1-0.86/1.07) = 5.10$

O.K. USE A THICKNESS OF 14"

$0.38\ \text{in}^2/\text{FT} = A'_s = A_s$ USING ULTIMATE STRENGTH

DEPARTMENT OF THE ARMY
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX E

ECONOMICS

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APPENDIX E

ECONOMICS

INTRODUCTION

1. This appendix presents an economic analysis of existing flood damages and benefits of the selected flood control plan in the Bassett Creek watershed, for an assumed economic life of 100 years. This analysis includes total and annual project costs and tangible flood control benefits, advance replacement benefits and redevelopment benefits attributable to the proposed project. Redevelopment benefits were not included in the final benefit-cost analysis, but were developed to show the potential redevelopment benefits resulting from the project.

FLOOD DAMAGES

General

2. Flood losses in the Bassett Creek watershed include physical damage caused by inundation, business losses due to decreased production, loss of profits and wages and increased cost of normal operation and living. Additional losses are incurred in flood fighting and flood preparation, but due to the short time of peak and short duration of the flood waters, these losses are small. Damages were obtained for the following categories:

3. Residential - Residential damages include inundation losses to all residences and upper tenant structures, including building contents and damage to grounds.

4. Commercial and Industrial - Damages include physical losses to properties and facilities used for retail and wholesale trade, services, manufacturing, and warehousing. Wage and profit losses where identified, and increased cost of normal operations resulting from evacuation and cleanup are also included.

5. Public - Damages include all costs associated with physical flood losses to

public property such as municipal, sewage, water and park systems. Other losses to the public include additional costs incurred during flood emergencies such as evacuation; flood fighting; disaster relief; and extra duty for police, fire and martial units.

6. Transportation - Transportation damages consist of the cost of additional mileage required because of inundated roadways and the resulting detours required.

DATA COLLECTION

7. Data was not available for major flood damages since major flooding has not recently occurred on Bassett Creek. Consequently, damages were estimated from Hennepin County property records, county traffic records, on-site visits, interviews and community records of cities within the Bassett Creek watershed.

8. Water surface elevation for low frequency floods used to calculate stage damage curves were obtained from water surface profiles and flood on lines developed using the Hydrologic Engineering Center's HEC-1 computer programs.

9. Commercial damages to commercial and industrial businesses were determined by interviews for those businesses in the 100 year floodplain. Damages to businesses in the SPF floodplain were estimated from elevation-damage curves developed by the U.S. Soil Conservation Service and the Baltimore District, U.S. Corps of Engineers, and updated by the St. Paul District in 1979. Damages were derived as a percentage of structure value. The percentages developed from this technique were compared to percentage of structural value for business that were interviewed. The percentages using the curves were lower than those derived from interviews. It was assumed that under estimating damages using this technique would not significantly affect the analysis for two reasons. First, the curves were used for structures in the SPF flood plain. The small change in annual damages would be minimal for low-frequency flooding. Second, benefits from changes in SPF flood plain damages are small for the 100-year design

project.

10. Residential - Residential structures within the SPF flood plain were identified from aerial photos, ortho maps and feasibility study surveys. Structural values were obtained from Hennepin County property records, and assesor's office. Elevations were obtained from two foot contour ortho maps, feasibility study surveys and on-site inspections. Damages were estimated using residential depth damage curves.

11. Public and Transportation - Public damages were derived from estimates of damages that would occur due to major flooding. The damages, were calculated from past low flow damages and estimates from watershed engineers. Transportation damages result from the additional cost of travel due to detours around the flooded area. Average annual daily traffic counts for county and state roads in the Bassett Creek area were obtained from the County Highway Department. Operating vehicle costs were obtained from the Department of Transportation. Areas of road inundation for the 100-year and SPF floods were obtained from flood profiles. Detour routes were derived by assuming traffic would use the county and state roads network to travel around the flooded area.

DAMAGE CALCULATION

12. Average annual flood damages were evaluated for 1981 conditions and were projected to 1986, when it is assumed the project would be completed, by estimating interim economic growth. Flood damages will also increase with ultimate urbanization or future development of the watershed that is currently undeveloped because runoff will increase and hydrologic conditions change. Due to the significant increase in flood discharge and flood levels in the watershed between existing urbanization and ultimate urbanization, damages were calculated for both these conditions. Based upon urban development projections prepared by the Metropolitan Council of the Twin Cities Area, and published in the

Metropolitan Development Guide, December 1977, ultimate urbanization would occur in 1995. With ultimate conditions, during the 100-year flood event, 171 residences would incur direct flood damages and 203 would incur indirect flood damages. For existing conditions, 75 would incur direct damages, and 105 would incur indirect damages.

13. Residential - Residential data was compiled and inputted into the Depth Damage System (DDS) program. The DDS program calculates depth damage curves for individual structures using Residential Depth Damage Curves. Flood elevations are inputted at specific stationing, corresponding to the structure location along the channel. Using water surface profiles developed for existing and ultimate urbanization conditions, frequency damage curves were developed for with and without project conditions. Both direct and indirect damages were calculated.

TABLE 1

Residential Frequency Damage Curves - Bassett Creek
(Damage Values in $1000)

Frequency	Damages without project		Damages with project	
	Existing	Ultimate	Existing	Ultimate
Direct Damages				
10-year	1350.2	1913.4	0	0
50-year	1750.3	3033.7	0	0
100-year	2497.1	5662.6	986.6	1498.3
SPF	17162.9	19003.6	11652.7	13222.9
Indirect Damages				
10-year	2282.5	2650.1	0	0
50-year	2681.1	2824.1	0	0
100-year	2853.6	2890.8	1384.3	1991.7
SPF	986.1	586.0	2657.7	2455.4
Total Damages				
10-year	3632.7	4563.5	0	0
50-year	4431.4	5857.8	0	0
100-year	5350.7	8553.4	2370.9	3490.0
SPF	18149.0	19589.6	14310.4	15678.3

14. Total damages were used in calculating benefits. Although Bassett Creek flooding is short duration, there is considerable flood damage due to sewer backup. During recent hi-frequency floods, damages were caused primarily by sewer backup. It was assumed that for low frequency floods indirect damages would also be a major part of total damages.

15. Commercial - Stage damage curves for commercial structures were developed for two reaches of Bassett Creek. The first reach, Minneapolis, included structures in the SPF floodplain from the conduit entrance to Glenwood Avenue. Most of the commercial structures in the watershed are in this reach, and consequently, most of the commercial flood damages are in this reach. (See Table 2.) The second reach, Golden Valley, included structures in the remaining SPF floodplain.

TABLE 2

Commercial Flood Damages
(Ultimate, without project conditions)

Flood Event	Damages ($1000) Reach - Minneapolis	Golden Valley
10-year	1348.2	52.7*
50-year	2328.8	245.0*
100-year	2907.6	536.4
SPF	9088.3	1834.0

*Estimate.

16. The Stage damage curves for individual structures were referenced to the starting points of the reaches by using water surface profiles developed for the project. The stage damage curves were then used in conjunction with stage frequency curves at the reference point, to determine average annual damages.

GROWTH OF PROJECTED FLOOD DAMAGES

17. Increase in flood damages due to future growth has been based upon expected increases in damages to residential contents and industrial and commercial establishments. No increase in flood damages due to new structures is expected

as existing flood plain regulations require new structures to be built above the elevation of the 100-year flood.

GROWTH TO EXISTING DEVELOPMENT

18. The per capita income index for the Minneapolis-St. Paul SMSA was used as the growth index for the contents of residential structures. Damages are expected to increase over time due to the increase in residential content value. Flood damages to contents are projected to increase at the same rate of change as real per capita income, up to the point where content value is 75% of structure value. The value of contents is currently estimated to be 25% of the residential structure value. Therefore, content value will increase by a factor of 3.0 (.75 divided by .25). Since real per capita income is projected to grow at a 2.1 percent compounded annual rate, content value will be 75 percent of structure value in 53 years (1.02153 = 3.0). The net factor increase for year 53 in residential damages is 1.5 ((0.25 x 3) x (0.75 x 1.0)). This factor (1.5), takes into account the expected increase in residential content damages.

19. Future increases in industrial and commercial damages were projected independently for each business enterprise within the 100-year flood plain. A personal interview was conducted with each firm in order to jointly determine which existing condition damage source will change in the future. Past patterns of internal growth within the firm and the firm's visible growth horizon were discussed. Based upon these discussions, realistic decisions were made concerning plant production capacities, inventory and/or stock material growth, production equipment improvements, sources of profit growth and changes in labor inputs (loss of wages). Rates of change and timing of changes for damages sustained were uniquely determined for each firm studied. Some near term increase in damages was also recognized based upon pending installation of pollution control devices and facilities currently required by government

regulatory agencies for specific industries. These improvements will be subject to flood damages. Because of the limited number of businesses with the 100-year flood plain sustaining damage and the possibility for unauthorized disclosure, a table of individual company damage projections is not included. However, the percent of damages subject to future increase and the percent determined to remain constant over the project life is presented in Table 4.

TABLE 3
Growth Components for Commercial-Industrial Units

Type of Damage	Firm A	Firm B	Firm C	Firm D	Firm E	Firm F	Firm G
Constant	82%	90%	39%	56%	96%	100%	100%
Subject to Growth	8%	10%	6%	44%	4%	0%	0%

20. Individual company projected damages were summed and an index of change over time determined. Very little growth after the year 2000 can be reasonably projected using this direct interview and study-of-the-firm method because change beyond the year 2000 is very difficult for private industry to anticipate. No growth was assumed for the remaining 50 years of the 100-year project life.

21. An estimate of growth for companies outside the 100-year floodplain was not developed. The same rate of growth was applied to these companies as to those in the 100-year floodplain. The rate of growth would be similar. The impact on the benefit analysis was also considered minimal since the reduction of SPF flooding is minimal and the total benefits from companies in the SPF is minor since the project is a 100-year design. Between 1980 and 2000 a 25 percent growth rate in commercial damages was calculated; between 2000 and 2030 a 4 percent growth rate in commercial damages was calculated.

EXPECTED ANNUAL DAMAGES

22. Average annual damages were estimated using the Expected Annual Damage (EAD) computer program developed at the Hydrologic Engineering Center. A complete description of the general principles of calculating average annual damages is presented in the users' manual for the program.

23. Residential damages for existing 1982 and ultimate (1995) conditions with and without project, with increases in content damages to year 2035 were input to the program. Commercial damages for existing and ultimate conditions with and without project, were input to the program with the increase in economic growth factor (25% to year 2000; 4% from year 200 to year 2030). The average annual residential and commercial damages for without and with project conditions are shown in Table 4. Project benefits for reducing flood damages are also listed. Total project residential and commercial flood reduction annual benefits are $1,417,750.

TABLE 4
Flood Damages and Project Benefits
(With economic and hydrologic changes)

	Average Annual Damages Without Project ($1000)	Average Annual Damages with Project ($1000) (Residual Damages)	Project Benefits ($1000)
Residential	1285.07	154.15	1130.92
Commercial			
Minneapolis Reach	314.14	54.09	260.05
Golden Valley Reach	34.77	8.00	26.78
TOTAL			$1417.75

NOTE: (7 5/8 percent interest rate, 100-year project life)

REDEVELOPMENT BENEFITS

GENERAL

24. In accordance with the Water Resources Council's Principles and Standards (38FR174), in areas having persistent unemployment or underemployment, project

benefits shall be increased by the value of labor and other resources required for project construction. Since parts of the area within the commuting distance of the project were designated in 1975 as areas of persistent unemployment, redevelopment benefits were evaluated. The benefits were not included in the benefit-cost ratio since the designation of these areas has changed. However this section provides an analysis of redevelopment benefits to be included in the final justification, if the designation is changed before project implementation.

METHODOLOGY AND ASSUMPTIONS

25. The recommended plan will have an effect upon the local economy. The initial investment will create new jobs and income flows, thereby directly reducing unemployment and underemployment. There will be demands for both labor and construction materials required for project construction and incomes of individuals in associated industries will be increased indirectly due to the interrelationship and interdependence of these industries. Included are such industries as manufacturing, retail and wholesale trade, etc. These conditions will stimulate the economy which will raise the general level of income.

26. Parts of all of 12 counties within a reasonable commuting distance (50 mile radius) of the project site were eligible for aid in 1975 pursuant to the Area Redevelopment Act (PL 87-27). Redevelopment benefits credited to the relief of unemployment and underemployment are only those allocated to eligible counties. In making the benefit allocation, estimates of unemployment were obtained from published sources while quantitative estimates of underemployment were developed on the basis of per capita income and civilian labor force data. It was determined that approximately 30 percent of the total redevelopment benefits would be the amount applicable to redevelopment counties. 1975 estimates of the Minnesota Department of Manpower Services indicate there are more than 7,000 unemployed construction workers available for work within commuting distance of

the project. Of this total, it is estimated that there are approximately 3,500 skilled, 2,100 semi-skilled and 1,400 unskilled workers. Therefore, an ample supply of labor is readily available.

27. Construction features evaluated include a new conduit, control structures, flood walls, channel modifications and relocations. Total construction cost of the recommended plan is estimated at $17,806,000. On-site labor cost as percentage of total construction cost, is estimated to be approximately 65 percent for urban projects similar to the recommended plan.[1] The distribution of total on-site labor for similar civil works are; skilled 31 percent, semi-skilled and unskilled 59 percent, and administration and supervisory 10 percent.[2] Based on similar projects constructed in the metropolitan area, it was determined that all of the skilled, semi-skilled and unskilled and 50% of the administrative labor required for the project would be hired from the local labor supply and these percentages would result in the amount of wages paid to locally hired unemployed or underemployed labor. Average annual redevelopment benefits credited to the construction phase of the recommended plan were estimated to be $251,700 based on interest and amortization computed at 7 5/8 percent over an economic life of 100-years. Derivation of these benefits is shown on Table 5.

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1. Engineering News Record, McGraw-Hill, Inc., September 18, 1975, Vol. 195, No. 12, p. 14.

2. IBID., June 19, 1975, Vol. 194, No. 25, p. 77.

TABLE 5
Redevelopment Benefits

Estimated On-Site Labor Cost

Construction Cost [1]	$17,806,000
Percent of Cost Allocated to Labor	65
On-Site Labor Cost	11,574,010

On-Site Labor by Employment Category

Classification of Labor	Percent	Wages
Skilled	31	3,588,000
Semi and Unskilled	59	6,829,000
Administrative & Supervisory	10	1,157,000
		$11,574,000

Allocation of Wages to Unemployed and Underemployed Labor

Classification of Labor	Wages	Percent Locally Hired Labor	Wages Paid to Locally Hired Labor
Skilled	$3,588,000	100	$ 3,588,000
Semi and Unskilled	6,829,000	100	6,829,000
Administrative & Supervisory	1,157,000	50	578,500
			$10,995,500

Redevelopment Benefits

Average Annual Value of Local Labor Component

$10,995,500 x .07630 = $838,960

Amount Applicable as Redevelopment Benefits

$838,960 x .30 = $251,700

[1] Includes total construction cost, less costs for engineering and design, supervision and administration, and land acquisition.

ADVANCE REPLACEMENT BENEFITS

28. Construction of the flood control project includes three features that replace four existing structures. These structures are currently in need of major repair or replacement. The existing conduit, outlet for Bassett Creek, and Currie Avenue Sewer, and the floodwalls and railroad bridge downstream of Glenwood Avenue are currently in need of replacement. Construction of the new conduit, floodwalls and bridge would obviate the need for repairing or replacing the existing structures. Accordingly, average annual costs of repair or replacement are considered to be a benefit attributable to the project. (See Table 6).

29. The estimated costs of a complete repair of the existing conduit and Currie Avenue Sewer would be $13,800,000 based on September 1982 construction costs. These costs are estimated to be $1,053,000 based on interest and amortization computed at 7 5/8% over an assumed economic life of 100 years.

30. The estimated replacement cost for the existing flood walls downstream of Glenwood Avenue would be $593,600 based on September 1982 construction costs. Average annual costs are estimated to be $45,200 based on interest and amortization computed at 7 5/8% over an assumed economic life of 100 years and assuming the replacement work would have to be completed by 1986.

31. The estimated costs of replacement of the existing railroad bridge would be $64,000 based upon September 1982 construction costs. Average annual costs are estimated to be $4,900, assuming the replacement work would have to be completed by 1986.

32. Total advance replacement benefits attributable to the project are estimated to be $1,103,100.

TABLE 6
Advance Replacement
(Annual Cost)

Conduit & Sewer	$13,800,000	(Cost of Replacement)
	.07630	(100 year life)
	$ 1,053,000(1)	(Annual Cost)
Floodwalls	$ 592,600	(Cost of Replacement)
	.07630	(100 year life)
	$ 45,200(1)	(Annual Cost)
Railroad Bridge	$ 64,000	(Cost of Replacement)
	.07630	(100 year life)
	$ 4,900	(Annual Cost)

(1) Replacement would be necessary in 1986, therefore benefits for advance replacement are the same as the cost of replacement.

PUBLIC BENEFITS

33. Public benefits were derived from reduction of damages to municipal facilities and reduction of flood emergency costs. The total average annual benefits was estimated at $80,900. This estimate was based on damage reductions developed from community or public works calculations.

TRANSPORTATION BENEFITS

34. Transportation benefits were derived from reduction of detour costs incurred from rerouting traffic around the flooded area. Seventeen county roads and major streets would require detours during the 100-year flood event. The project would eliminate the need for detours. The reductions were based upon an average detour length of 3.5 miles and duration of 6 hours. Using variable operating costs per mile, the reductions in annual detour costs was estimated at $1000.

SUMMARY OF MONETARY BENEFITS

35. Benefits attributable to the selected flood control plan include tangible flood control benefits from the reduction of flood damages, advance replacement benefits, and benefits associated with the decreased threat to human life and public health. Additional tangible benefits which result from the project,

which were not evaluated, include the foregone cost of flood proofing, land enhancement, and the savings in the administrative costs of flood insurance. Based on September 1982 prices, a 100-year economic life and a 7 5/8% interest rate, total average annual flood damage reduction benefits attributable to the project are $2,802,100, and the estimated average annual residual flood damages with the project are $245,000. A summary of Average Annual Benefits is given in Table 7.

36. Redevelopment benefits would increase Average Annual benefits by $251,700.

37. The proposed project at Bassett Creek complies with Executive Order 11988. It would significantly reduce flood risk to existing development with measures that address the dual objectives of national economic development and environmental quality. The proposed measures represent the only practicable alternative. Appropriate consideration has been given in the planning process to nonstructural measures. The area communities have implemented floodplain development restrictions, and have purchased developable floodplain to prevent future flood damages to new development.

TABLE 7
Summary of Average Annual Benefits

Item			Average Annual Benefits
Flood control			
Residential	1,130,920		
Commercial	286,830		
Public	80,900		
	1,498,650(1)	Update Factor(2) X 1.133 =	1,698,000
Advance Replacement			1,103,100
Transportation			1,000
TOTAL			$2,802,100

(1) October 1981 prices.
(2) To compare with Average Annual Costs, which are in September 1982 prices, the Average Annual Benefits were updated from October 1981 prices to September 1982 prices.

BENEFIT COST ANALYSIS

38. Annual Costs - Annual costs for the project are the same of amortized first costs and annual operations and maintenance costs. First costs include interest during construction for the cost of conduit construction since this feature will be constructed over a 3-year period. Other features will be completed within one construction season.

Calculations below show annual costs to be $2,329,000

Calculation of annual charges for the proposed project.
(September 1982 prices; 7 5/8 percent interest rate)

Item	Amount
First Costs	$28,540,000
Interest During Construction	1,757,000
Total	$30,297,000
Interest & Amortization (30,297,000 x 0.07630)	$ 2,311,700
Operation & Maintenance	17,500
Total Annual Charges	$ 2,329,200

ANNUAL BENEFITS

39. Total Average Annual Benefits were estimated at $2,802,100 in September 1982 prices.

RELATIONSHIP OF BENEFITS TO COSTS

40. The project has annual benefits of $2,802,000 and annual costs of $2,329,200, resulting in a benefit-cost ratio of 1.20.

AREA REDEVELOPMENT

41. If the Bassett Creek area was reclassified as an area of persistent unemployment, redevelopment benefits could be attributable to the project. This would result in an increase in annual benefits to $3,053,800 and a change in the BCR to 1.31.

DEPARTMENT OF THE ARMY

St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX F

DETAILED COST ESTIMATE

September 1982

APPENDIX F

BASSETT CREEK

DETAILED ESTIMATE OF FIRST COSTS

	Unit	Quantity	Unit Cost	Total Cost	
Federal First Costs and Non-Federal Contributions					
Relocations					
Flood Proofing (24 Houses-App. H, Page H-26)	Job	Sum	-	398,600	
Railroad Bridge	-	-	-	-	
Concrete	C.Y.	273	200	54,600	
Bearing Piles	L.F.	504	120	60,480	
Railroad Ties	L.F.	808	10	8,080	
Contingencies				18,240	
Total Relocations					540,000
Channels					
Conduit					
Mn/DOT 2nd St. Tunnel	Job	Sum	-	3,000,000	
10' ø Precast Tunnel	L.F.	5,100	1,500	7,650,000	
Cath. Arch Tunnel	L.F.	1,600	1,000	1,600,000	
Contingencies				1,350,000	
Channel Modifications					
Penn Avenue Bridge					
Excavation	C.Y.	1,750	2.50	4,375	
12" Riprap w/6" Bedding	S.Y.	2,620	16.50	43,230	
Old Bridge Removal	Job	Sum		10,000	
Contingencies				8,395	
Fruen Mill Area					
Excavation	C.Y.	7,750	2.00	15,500	
Fill	C.Y.	1,610	2.00	3,220	
Sheet Piling	S.F.	9,240	13.00	120,120	
New Railroad	L.F.	755	60.00	45,300	
36" RCP w/Flapgate	L.F.	72	120.00	8,640	
Chain Link Fence	L.F.	205	10.00	2,050	
Remove Railroad Bridge	Job	Sum		10,000	
Crushed Rock	C.Y.	300	8.00	2,400	
Riprap	C.Y.	900	25.00	22,500	
Contingencies				34,270	

BASSETT CREEK

DETAILED ESTIMATE OF FIRST COSTS

	Unit	Quantity	Unit Cost	Total Cost	
<u>Channel Modifications</u> (Continued)					
Markwood Area					
115" x 72" RCP-A	L.F.	2,030	390.00	791,700	
Sodding	S.Y.	5,000	2.00	10,000	
84" x 54" RCP-A	L.F.	120	300.00	36,000	
24" RCP	L.F.	20	90.00	1,800	
Catch Basins 24" Beehive	Ea.	6	500.00	3,000	
Box Inlets	Ea.	5	9,000	45,000	
Connection Box	Ea.	1	6,000	6,000	
115" x 72" RCP-A	L.F.	120	390.00	46,800	
Contingencies				140,700	
Minnaqua Avenue Bridge Removal					
Lump Sum as Bid	Job	Sum	-	6,625	
Contingencies				375	
<u>Storage Areas</u>					
Tunnel Inlet Ponding					
Excavation	C.Y.	125,000	2.00	250,000	
Excavation, Disposal at Landfill	C.Y.	125,000	5.75	718,750	
Shaping at Landfill	C.Y.	125,000	.35	43,750	
Random Fill	C.Y.	24,000	2.00	48,000	
18" Riprap w/9" Bedding	S.Y.	20	25.00	500	
Drop Inlet Sturcture	C.Y.	100	250.00	25,000	
Contingencies				163,000	
Edgewood Area					
Excavation	C.Y.	31,500	2.00	63,000	
Cul-de-Sac					
4" Bituminous	S.Y.	320	6.00	1,920	
6" Base Coarse	S.Y.	320	2.00	640	
18" Riprap w/12" Bedding	S.Y.	3,150	16.20	51,030	
48" Manhole (10') SD	Ea.	4	2,750	11,000	
12" RCP - SD	L.F.	16	25.00	400	
18" RCP - SD	L.F.	70	25.00	1,750	
30" CMP - SD	L.F.	34	60.00	2,040	
Remove Existing Sanitary Sewer	L.F.	1,150	2.00	2,300	
Contingencies				19,920	
<u>Beautification</u> (App. G, Page G-4)				200,000	
Total Channels					16,621,000

BASSETT CREEK

DETAILED ESTIMATE OF FIRST COSTS

	Unit	Quantity	Unit Cost	Total Cost
Flood Control Structures				
Tunnel Inlet Drop Structure				
Concrete	C.Y.	309	300.00	92,700
Safety Cap	L.F.	42	20.00	840
Trash Rack	Ea.	1	2,000	2,000
Contingencies				14,460
Highway 55				
Control Structure				
Concrete	C.Y.	68	300.00	20,400
Handrailing	L.F.	28	15.00	420
Remove Wing Wall	C.Y.	23	250.00	5,750
Dewatering (Diversion)	Job	Sum	-	2,000
Contingencies				4,430
Highway 100				
Pervious Fill	C.Y.	48,700	2.00	97,400
Impervious Fill	C.Y.	1,075	12.00	12,900
Clearing and Grubbing	Acre	0.1	4,000	400
Topsoil	C.Y.	1,450	3.00	4,350
Seed	Acre	2.7	900.00	2,430
Excavate and Fill (Impervious)	C.Y.	15,000	14.50	217,500
Curb and Gutter	L.F.	1,120	8.50	9,520
36" C.M.P.	L.F.	125	60.00	7,500
Control Structure				
Excavation	C.Y.	1,300	2.50	3,250
18" Riprap	C.Y.	325	36.00	11,700
9" Bedding	C.Y.	160	15.00	2,400
Concrete	C.Y.	457	250.00	114,250
Contingencies				72,400

BASSETT CREEK

DETAILED ESTIMATE OF FIRST COSTS

	Unit	Quantity	Unit Cost	Total Cost
Flood Control Structures (Continued)				
Golden Valley Country Club				
Excavation	C.Y.	700	2.50	1,750
Embankment Fill	C.Y.	1,600	2.00	3,200
Concrete	C.Y.	75	250.00	18,750
Riprap	C.Y.	565	36.00	20,340
Bedding	C.Y.	280	15.00	4,200
Culverts (4' x 6' Box)	L.F.	178	150.00	26,700
Stripping	C.Y.	420	3.00	1,260
Clearing & Grubbing	Acre	0.1	4,000	400
Asphalt Pavement 2"	S.F.	1,050	4.00	4,200
Topsoil	C.Y.	275	1.00	275
Seeding	Acre	0.5	900.00	450
Concrete	C.Y.	200	250.00	50,000
Grouted Riprap	C.Y.	10	50.00	500
Contingencies				19,975
Edgewood Area				
Embankment				
73" x 45" RCP-A CL IV w/ Apron	L.F.	64	180.00	11,520
102" x 62" RCP-A CL IV w/ Apron	L.F.	60	310.00	18,600
73" x 45" to 102" x 62" transition	Ea.	1	700.00	700
Impervious Fill	C.Y.	3,450	2.00	6,900
Stripping	C.Y.	425	2.00	850
Clearing & Grubbing	Acre	0.4	4,000	1,600
Inspection Trench	C.Y.	275	8.00	2,200
Topsoil	C.Y.	235	1.00	235
Seeding	Acre	0.3	900.00	270
Gabions 12"	C.Y.	340	85.00	28,900
Bedding	C.Y.	170	15.00	2,550
Sheet Pile	S.F.	1,270	12.00	15,240
Excavation for Gabions	C.Y.	616	2.50	1,540
Concrete	C.Y.	150	300.00	45,000
Conduit and Stilling Basin				
Excavation	C.Y.	1,700	2.50	4,250
Riprap	C.Y.	350	36.00	12,600
Bedding	C.Y.	140	15.00	2,100
Topsoil	C.Y.	30	1.00	30
Misc. Impervious Fill	C.Y.	300	2.00	600
Channel Excavation	C.Y.	480	2.50	1,200
Contingencies				23,115

BASSETT CREEK

DETAILED ESTIMATE OF FIRST COSTS

	Unit	Quantity	Unit Cost	Total Cost	
Flood Control Structures (Continued)					
Wisconsin Avenue Embankment					
Pervious Fill	C.Y.	1,100	12.00	13,200	
Excavation	C.Y.	830	2.50	2,075	
Impervious Fill	C.Y.	1,000	2.00	2,000	
Concrete	C.Y.	17	500.00	8,500	
Precast Culvert, Conc. 8' x 6'	L.F.	70	390.00	27,300	
Fence	L.F.	100	5.00	500	
Topsoil	C.Y.	100	6.00	600	
Seeding	Acre	0.2	900.00	180	
Contingencies				8,645	
Winnetka Avenue Berm					
Impervious Fill	C.Y.	23	10.00	230	
24" CMP w/Flapgate	L.F.	90	105.00	9,450	
Contingencies				1,320	
Total Flood Control Structures					1,105,000
Engineering and Design					2,711,000
Supervision and Administration					
Inspection				822,000	
Overhead				961,000	
Total Cost (Federal First Costs and Non-Federal Contributions)					22,760,000
Non-Federal Contributions					460,000
TOTAL FEDERAL FIRST COSTS					22,300,000

BASSETT CREEK

DETAILED ESTIMATE OF FIRST COSTS

	Unit	Quantity	Unit Cost	Total Cost
Non-Federal First Costs				
Lands and Damages				3,740,000
Relocations				
Channel Crossings				
Nobel Avenue				
Regent Avenue	Items have been			
32nd Avenue	constructed or			
Brunswick Avenue	bids have been			
Adams Avenue	received totaling			1,051,000
34th Avenue				
36th Avenue				
Westbrook Road				
107" x 169" RCP-A III	L.F.	134	550.00	73,700
18" Riprap w/9" Bedding	S.Y.	350	16.20	5,670
Excavation	C.Y.	370	2.50	925
Road Replacement				
4" Bituminous	S.Y.	4,000	6.00	24,000
6" Base Coarse	S.Y.	4,330	2.00	8,660
Contingencies				17,045
Douglas Drive				
Pavement Removal	S.Y.	337	2.00	674
72" Culvert Removal	Job	Sum		2,400
Pavement, Concrete 8"	S.Y.	307	16.00	4,912
Pavement, Concrete 4"	S.Y.	22	10.00	220
Pavement, Asphalt 1 1/2"	S.Y.	40	4.00	160
Excavation	C.Y.	1,220	2.50	3,050
Backfill, Pervious	C.Y.	440	12.00	5,280
Bedding	C.Y.	120	16.00	1,920
Box Culvert 7' x 4'	L.F.	261	380.00	99,180
24" CMP	L.F.	32	50.00	1,600
18" RCP	L.F.	21	40.00	840
10" D.I.P.	L.F.	34	40.00	1,360
Contingencies				32,344

BASSETT CREEK

DETAILED ESTIMATE OF FIRST COSTS

	Unit	Quantity	Unit Cost	Total Cost	
Utility Relocations					
Tunnel Inlet Ponding					
48" Manhole	Ea.	3	2,750	8,250	
84" RCP Sewer	L.F.	862	370.00	318,940	
Contingencies				48,810	
Penn Avenue Bridge					
24" D.I.P. Watermain	L.F.	85	60.00	5,100	
12" Steel Gasline	L.F.	100	40.00	4,000	
Contingencies				1,400	
Fruen Mill Area					
Drop Structure					
Concrete	C.Y.	106	300.00	31,800	
Remove Rock Dam	Job	Sum	-	1,500	
Replace 6" Watermain	L.F.	60	70.00	4,200	
Contingencies				8,000	
Highway 100					
Remove and replace 3 1/2" Asphalt Road	S.F.	15,000	0.70	10,500	
Replace 8" VCP with 8" PVC S.S.	L.F.	360	12.00	4,320	
Replace Waterline	L.F.	360	20.00	7,200	
48" S.S. Manhole	Ea.	1	2,750	2,750	
48" S.S. Manhole Extension	Ea.	1	1,750	1,750	
Contingencies				3,480	
Edgewood Area					
48" Manhole S.S.	Ea.	8	2,750	22,000	
10" PVC S.S.	L.F.	1,360	11.00	14,960	
Contingencies				5,040	
Medicine Lake Outlet Structure					
Sheet Piling	S.F.	12,910	12.00	154,920	
Timber Lagging	S.F.	134	35.00	4,690	
Concrete	C.Y.	26	250.00	6,500	
Steel Plate	Lbs.	4,650	2.00	9,300	
Contingencies				24,590	
Total Relocations					2,040,000

BASSETT CREEK

SUMMARY OF NON-FEDERAL FIRST COSTS

Non-Federal First Costs	
Lands and Damages	$3,740,000
Flood Proofing (20% of Total Cost)	80,000
Relocations	2,040,000
Indirect Costs (Mn/DOT - 3rd Ave.)	380,000
TOTAL NON-FEDERAL FIRST COSTS	$6,240,000

Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK
HENNEPIN COUNTY, MINNESOTA
DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX G

BEAUTIFICATION MEASURES

TABLE OF CONTENTS

APPENDIX G

BEAUTIFICATION PLAN

INTRODUCTION

1. The basic flood control measures proposed as part of the Bassett Creek project will have varying degrees of adverse visual impacts upon the project area (i.e., construction of some measures will have significant impacts while others will result in slight impacts). To offset these impacts and to make the Bassett Creek project more socially and environmentally acceptable, beautification measures are proposed (e.g., landscaping, rustification, etc.). This appendix provides a brief discussion of the types of aesthetic impacts the basic flood control project could have on the resource and provides a conceptual beautification plan to help offset these impacts (see the following plates for details). A rough estimate of the cost associated with implementation of the beautification plan is also included. Detailed planting plans will need to be fully developed in future studies to coordinate exact locations and species to be implemented.

PROJECT RELATED AESTHETIC IMPACTS AND ASSOCIATED BEAUTIFICATION MEASURES

2. GOLDEN VALLEY COUNTRY CLUB EMBANKMENT

Impacts - A portion of the golf course will be disturbed by the construction of a concrete box culvert. The existing bridge and path will need to be removed. Some visual resources will therefore be affected.

Beautification Measures - The path will be realigned and landscape plantings will be incorporated into the overall plan to minimize visual impacts. The exact species and locations for these plantings will be carefully coordinated with golf course representatives in future studies so as not to affect operations of the golf course. See plate G-1 for details.

3. CULVERT REPLACEMENT AT WESTBROOK ROAD

Impacts - Construction of these culverts will result in the loss of existing vegetation adjacent to the bridge.

Beautification Measures - Plantings of flood tolerant shrubs and trees along the affected construction zone is proposed. See plate G-1 for details.

4. CULVERT REPLACEMENT AT 34TH AVENUE

Impacts - Construction needed for making the necessary improvements to this site will disturb the vegetation in this area.

Beautification Measures - Proposed plantings will help offset the loss of vegetation and restore the visual setting of the neighborhood. See plate G-2 for details.

5. IMPROVEMENTS AT HIGHWAY 100

Impacts - Considerable change in earth form/grade and loss of existing vegetation would result from implementation of this measure.

Beautification Measures - To help offset this disruption, groups of plantings are proposed at strategic locations. The use of warp sections along the levee near Medicine Lake Road is also proposed. Care during construction should help minimize the loss of existing vegetation in this area (e.g., apple trees, etc.). See plate G-2 for details.

6. BRIDGE REMOVAL AT MINNAQUA AVENUE

Impacts - Closure and removal of this bridge will not be a major aesthetic impact. However, some measures to make the feature aesthetically acceptable are warranted.

Beautification Measures - Limited plantings of a horticultural nature are proposed to terminate the road, buffer the disturbed area, and make the project more acceptable to the neighborhood affected. See plate G-2 for details.

7. BASSETT CREEK CLEARING AND WIDENING NEAR 36th AVENUE NORTH

Impacts - The implications of this construction are signficant to neighborhood aethetics. Adverse impacts would be considerable.

Beautification Measures - To help offset the aesthetic impacts associated with this construction, a large number and variety of plant materials would need to be incorporated into the overall plan. Careful coordination with affected landowners will be necessary in future studies to identify the location and species. See plate G-3 for details.

8. PENN AVENUE CULVERT

Impacts - Changes in riparian contours adjacent to the culvert will result in unavoidable impacts on the existing vegetation.

Beautification Measures - The planting of flood-tolerant species of trees and shrubs to restore this area is recommended. See plate G-4 for details.

9. NOBEL AVENUE CULVERT

Impacts - Access requirements for removal of the old culvert and upgrading of structures will impact the site somewhat.

Beautification Measures - Plantings are proposed to offset the loss of vegetation and to restore the project area (as viewed from Noble Avenue). See plate G-4 for details.

10. STATE HIGHWAY 55 CONTROL STRUCTURE

Impacts - Aesthetic implications of construction of this flood control measure are limited to disruption of vegetation adjacent to the proposed control structure.

Beautification Measures - Limited landscape plantings are proposed to restore the project area; particular attention would be given to views from State Highway 55 towards the site. See plate G-4 for details.

11. REGENT AVENUE NORTH CULVERT

Impacts - The extent of visual disruption to the site will be limited to the immediate area of construction/access.

Beautification Measures - Limited landscape plantings are proposed to restore the project as viewed from Regent Avenue North. See plate G-4 for details.

12. FRUEN MILL CHANNEL IMPROVEMENTS

Impacts - The proposed flood control measures at this site would invovle removal of the existing stone dam, addition of floodwalls and riprap along portions of the shoreline, and construction of a new drop structure. Although implementing these features would have aesthetic impacts, some of the area is aesthetically deteriorated so net impacts associated with the flood control features are limited. The area is located in a heavy use area because of the proximity of the Fruen Mill, existing parklands, and a trail. Therefore, relocation and enhancement of the project area is recommended.

Beautification Measures - The inclusion of rustification measures on the concrete floodwalls, landscape planting to buffer disturbed areas and installation of aesthetically pleasing fencing is recommended. These measures would be highly visible to the public and would make the project more acceptable. See plate G-5 for details.

13. MOUTH OF MEDICINE LAKE

Impacts - Channel modifications proposed by the project would have significant visual impacts because of the loss of existing vegetation.

Beautification Measures - Landscape planting is recommended to help offset adverse impacts from South Shore Drive and from the existing nearby residences. See plate G-6 for details.

14. EDGEWOOD STORAGE AREA

Impacts - The development of ponding areas in this area will result in considerable vegetative disruption. Visually, because of the high frequency of observation of this area, the aesthetic impact could be significant.

Beautification Measures - Implementation of substantial landscape plantings and the development of a small permanent pond between Georgia and Florida Avenues is recommended. These measures should help offset project effects on visual resources. See plate G-6 for details.

15. BRUNSWICK AVENUE AND 32nd AVENUE FEATURES

Impacts - Visual impacts caused by construction of these proposed flood control features will be limited to access disruptions.

Beautification Measures - To offset the visual impacts of construction, limited landscape planting are proposed. See plate G-6 for details.

16. BASSETT CREEK OVERFLOW PONDING AREA

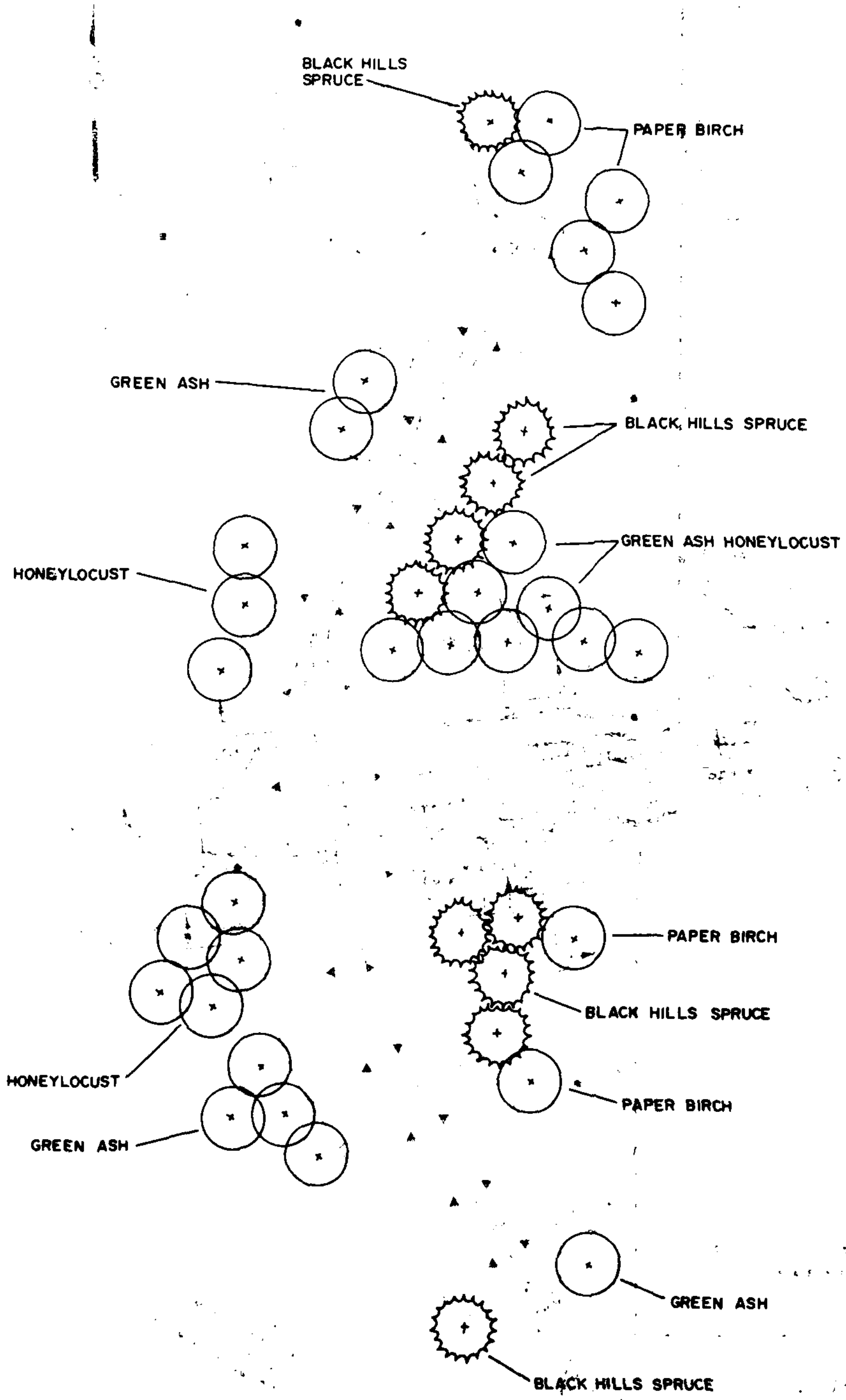
Impacts - This area is currently a railroad yard and landfill area which has limited aesthetic qualities. However, the proposed project would require considerable earthwork resulting in significant vegetation loss.

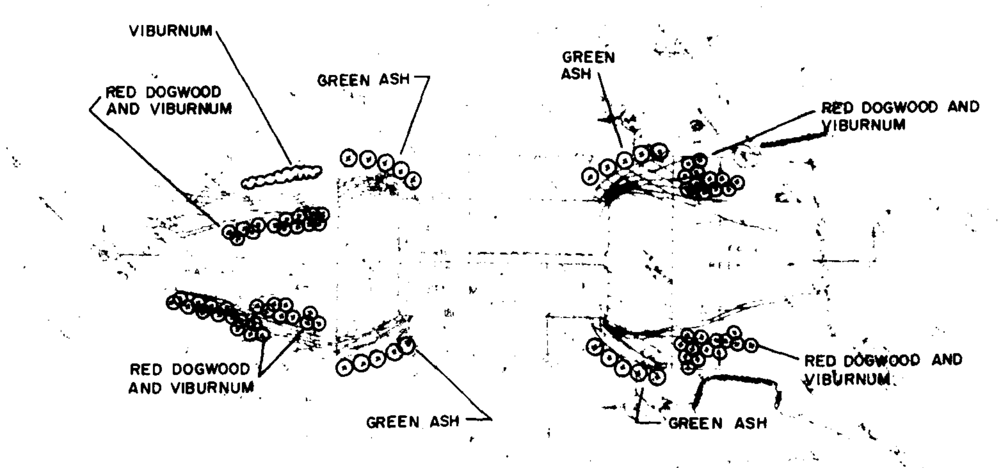
Beautification Measures - To offset visual impacts of the proposed construction activities, considerable landscaping and mounding of earth is proposed. Realignment of the creek channel is also proposed. See plate G-7 for details.

COST ESTIMATE

17. Costs associated with implementing the recommended beautification plan are estimated at $200,000. This estimate does not include the cost of turf establishment. Estimated costs have been broken down as follows (costs do include contingencies):

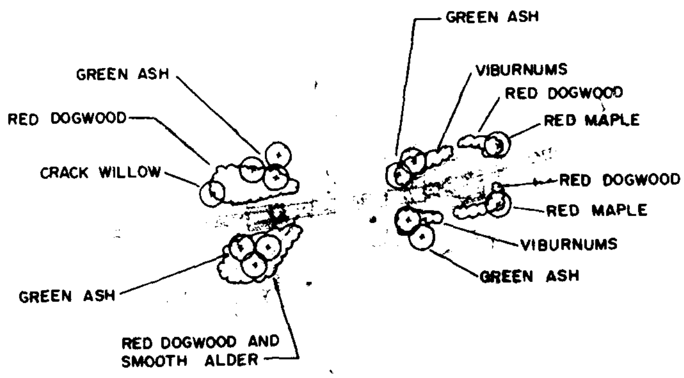
Items	Quantity	Average unit cost (planted)	Subtotal
Trees	700	$150.00	$105,000
Shrubs	2,000	15.00	30,000
Earthwork/shaping	Job	--	25,000
Excavation (create pond)	10,000 cu yd	4.00/cu yd	35,000
Rustification	Job	--	5,000
Estimated total	$200,000		

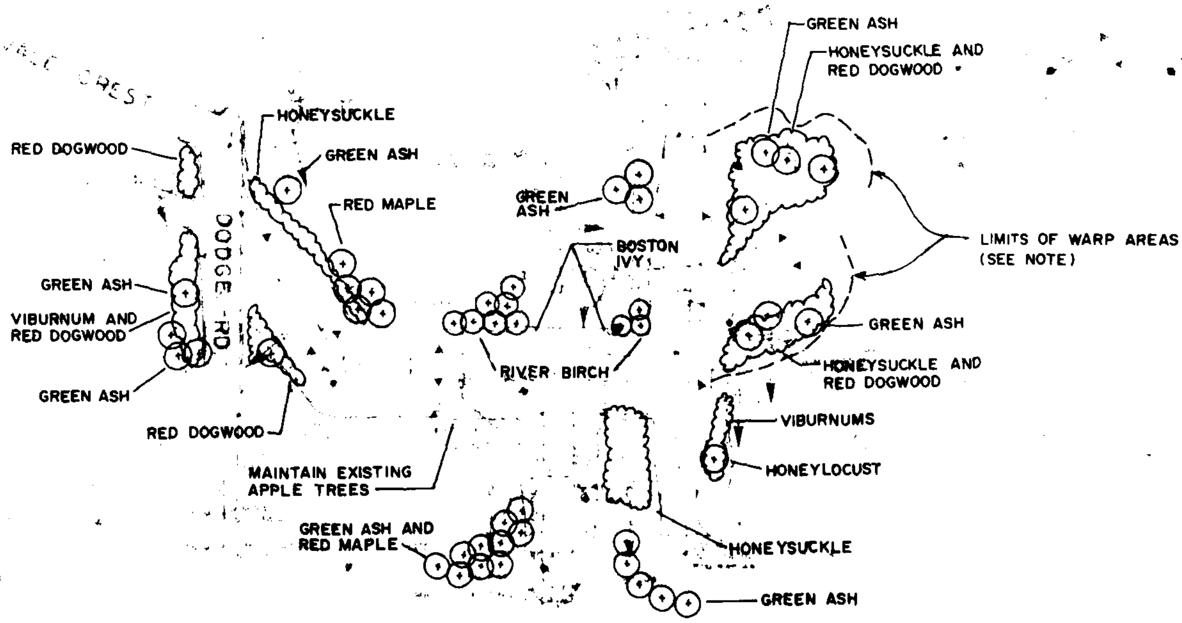

BLACK HILLS SPRUCE
PAPER BIRCH
GREEN ASH
BLACK HILLS SPRUCE
GREEN ASH HONEYLOCUST
HONEYLOCUST
PAPER BIRCH
BLACK HILLS SPRUCE
HONEYLOCUST
PAPER BIRCH
GREEN ASH
GREEN ASH
BLACK HILLS SPRUCE

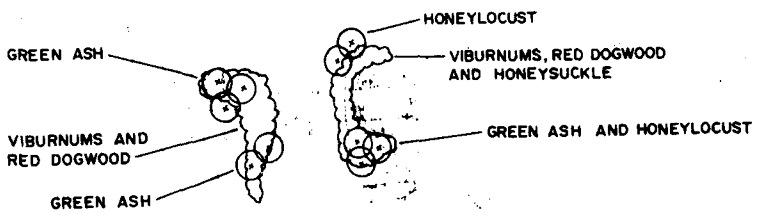


DEPARTMENT OF THE ARMY

PLATE G-1


GREEN ASH
RED DOGWOOD
CRACK WILLOW
GREEN ASH
RED DOGWOOD AND
SMOOTH ALDER
GREEN ASH
VIBURNUMS
RED DOGWOOD
RED MAPLE
RED DOGWOOD
RED MAPLE
VIBURNUMS
GREEN ASH


RED DOGWOOD
HONEYSUCKLE
GREEN ASH
RED MAPLE
DODGE RD
GREEN ASH
VIBURNUM AND
RED DOGWOOD
GREEN ASH
RED DOGWOOD
MAINTAIN EXISTING
APPLE TREES
GREEN ASH AND
RED MAPLE
GREEN ASH
BOSTON
IVY
RIVER BIRCH
GREEN ASH
HONEYSUCKLE AND
RED DOGWOOD
LIMITS OF WARP AREAS
(SEE NOTE)
GREEN ASH
HONEYSUCKLE AND
RED DOGWOOD
VIBURNUMS
HONEYLOCUST
HONEYSUCKLE
GREEN ASH



NOTE: WARP SECTIONS ARE AREAS OF ADDITIONAL FILL OVER LEVEE AREAS WHICH ARE CREATED TO ALLOW FOR PLANTINGS ON THE LEVEE (I.e. ALLOWS FOR ROOT FREE ZONE)

AND

LIMITS OF WARP AREAS (SEE NOTE)

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APPROVED

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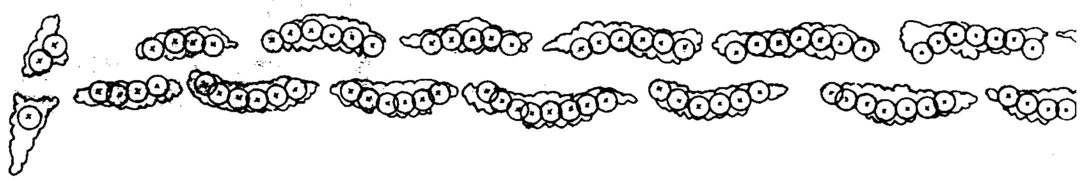


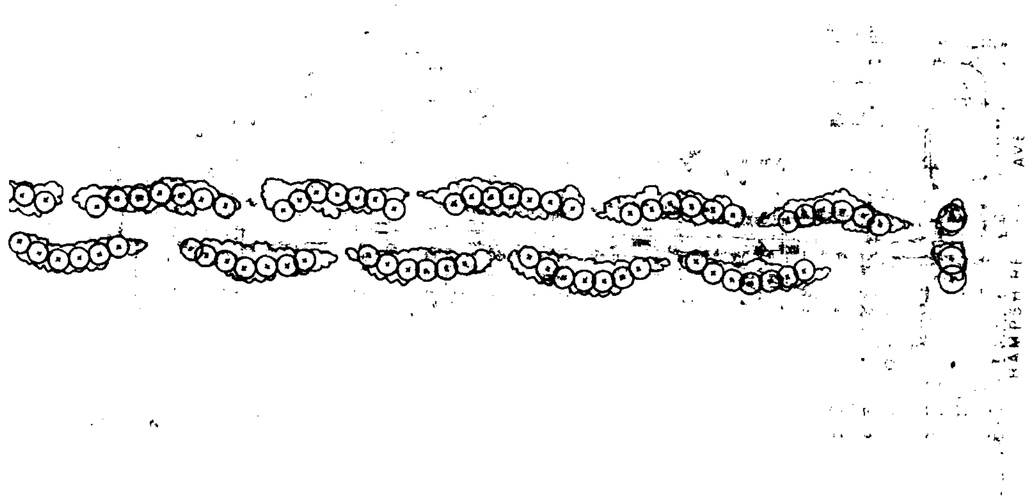
NOTES

1. BASSETT CREEK CHANNEL TO BE WIDENED. EXISTING PLANT SPECIES TO BE REMOVED. A 50' DIA. CHANNEL WAS PROJECTED HERE. THIS BEING THE UPPER LIMIT OF SIZE. ALL NEW PLANT SPECIES MUST BE MOISTURE TOL.

2. POSSIBLE PLANT SPECIES TO BE USED INCLUDE:

TREES
- RED MAPLE
- SILVER MAPLE
- GREEN ASH
- AMUR MAPLE
- WHITE ASH
- HONEY LOCUST
- CRACK WILLOW
- RUSSIAN OLIVE
- RIVER BIRCH
- BLACK HILLS SPRUCE

SHRUBS
- RED DOGWOOD
- STAGHORN SUMAC
- AMERICAN PLUM
- VIBURNUMS
- HONEYSUCKLE
- ALDER



EXISTING
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DEPARTMENT OF THE ARMY
ST PAUL DISTRICT, CORPS OF ENGINEERS
ST PAUL, MINNESOTA

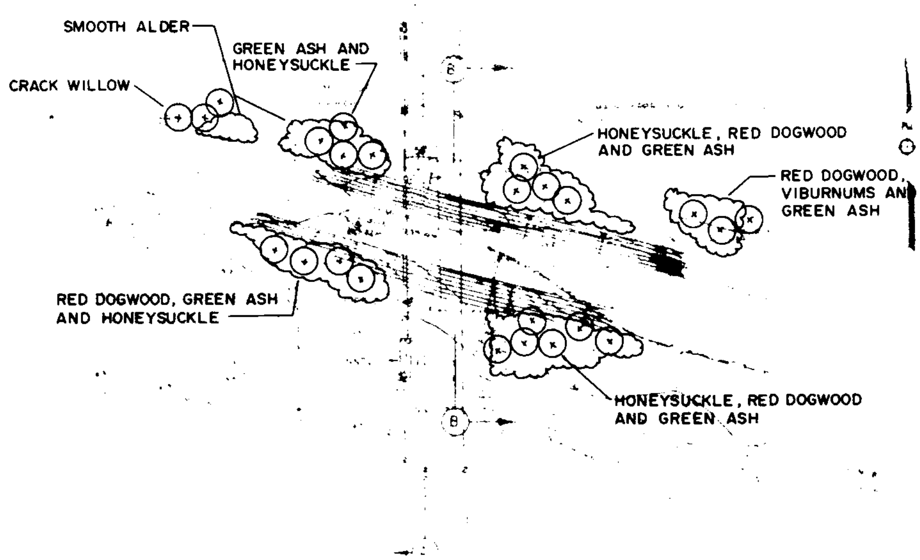
PHASE
DESIGN MEMORANDUM

FLOOD CONTROL BASSETT CREEK MINNESOTA

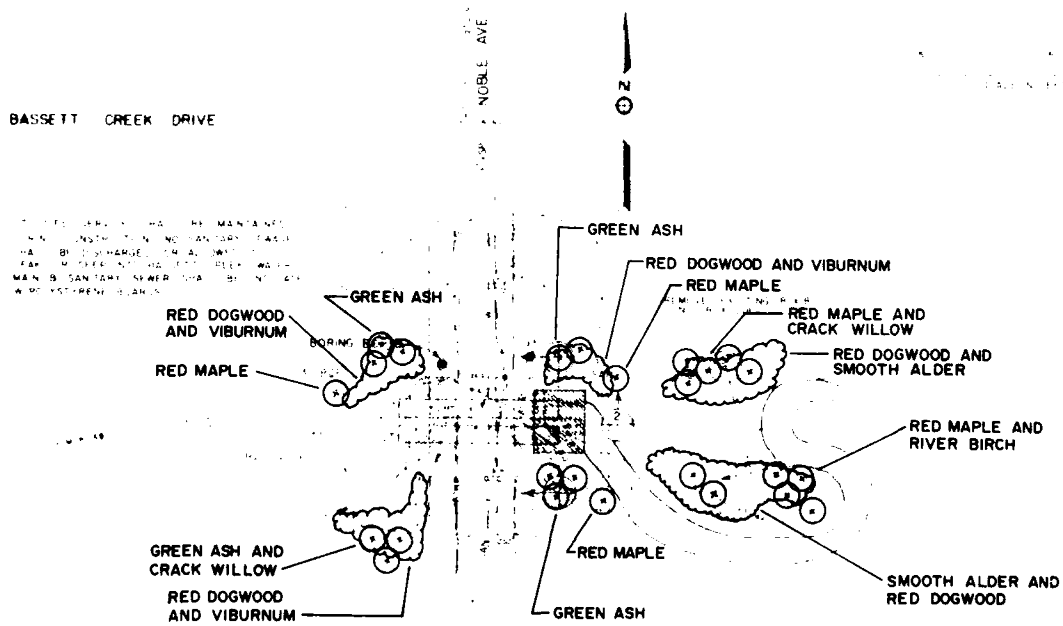
NORTH BR CHANNEL N 34th AVE
PLANTING PLAN

DATE
AUGUST 1982

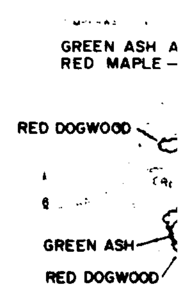
PLATE G-3



PENN. AVE. CULVERT REMOVAL



CULVERT REPLACEMENT AT NOBLE AVE



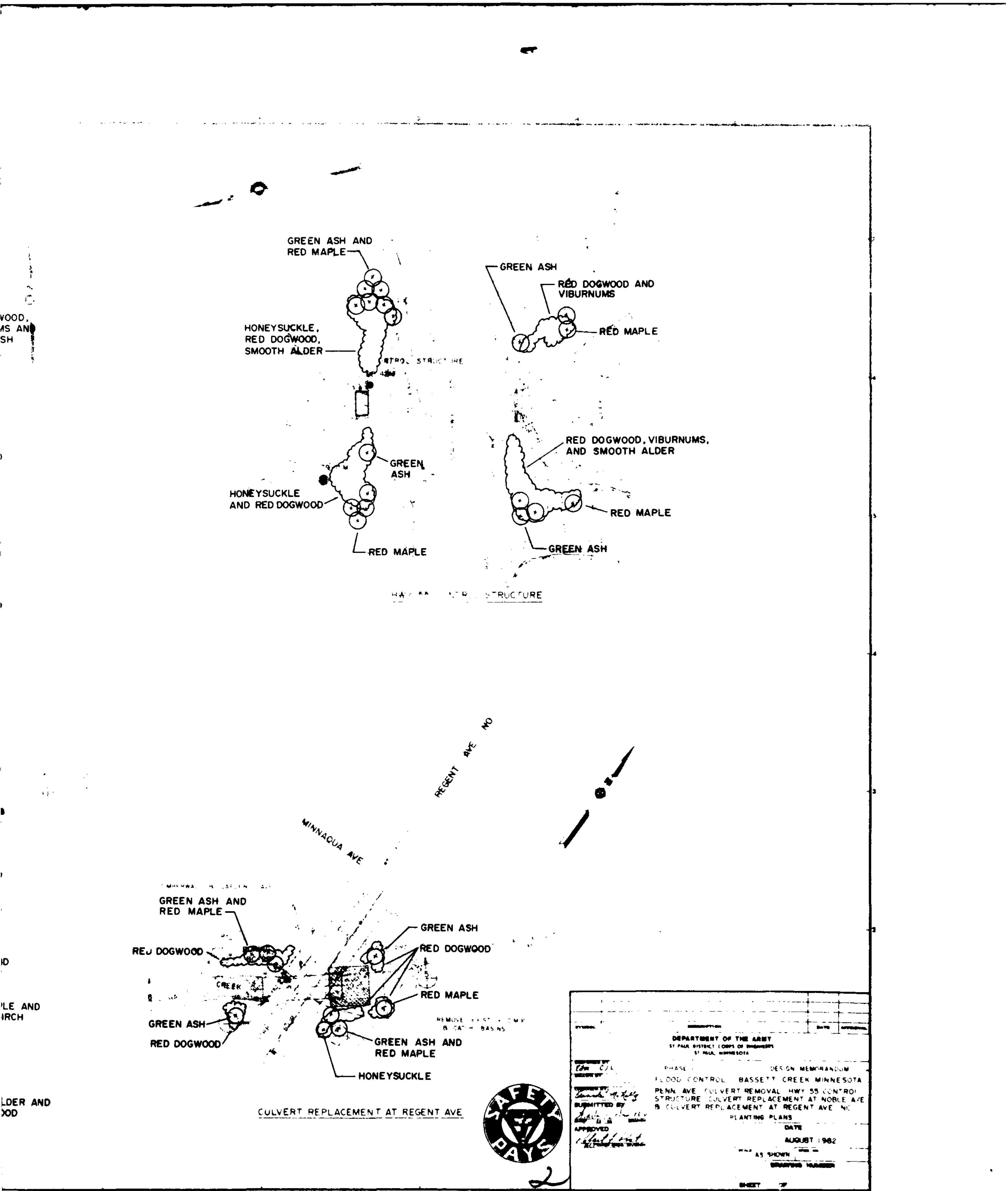
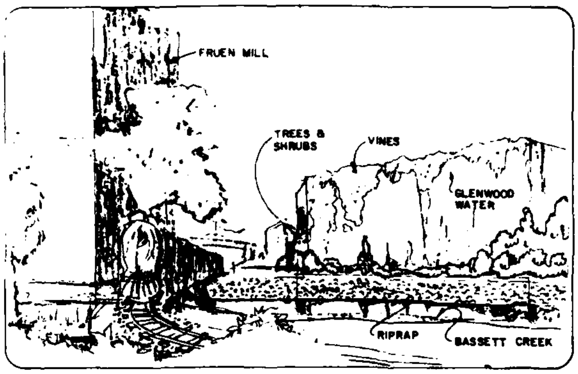
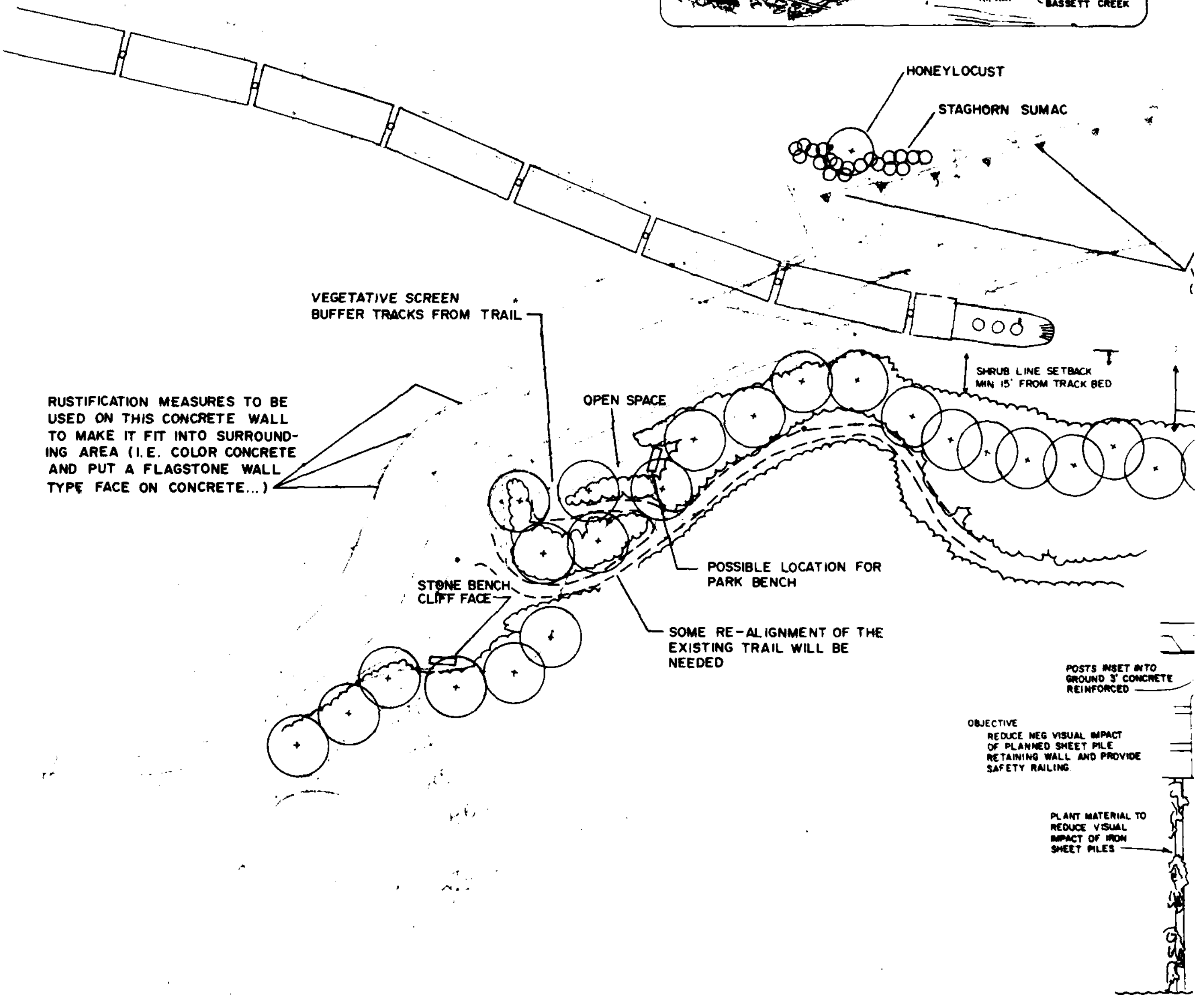
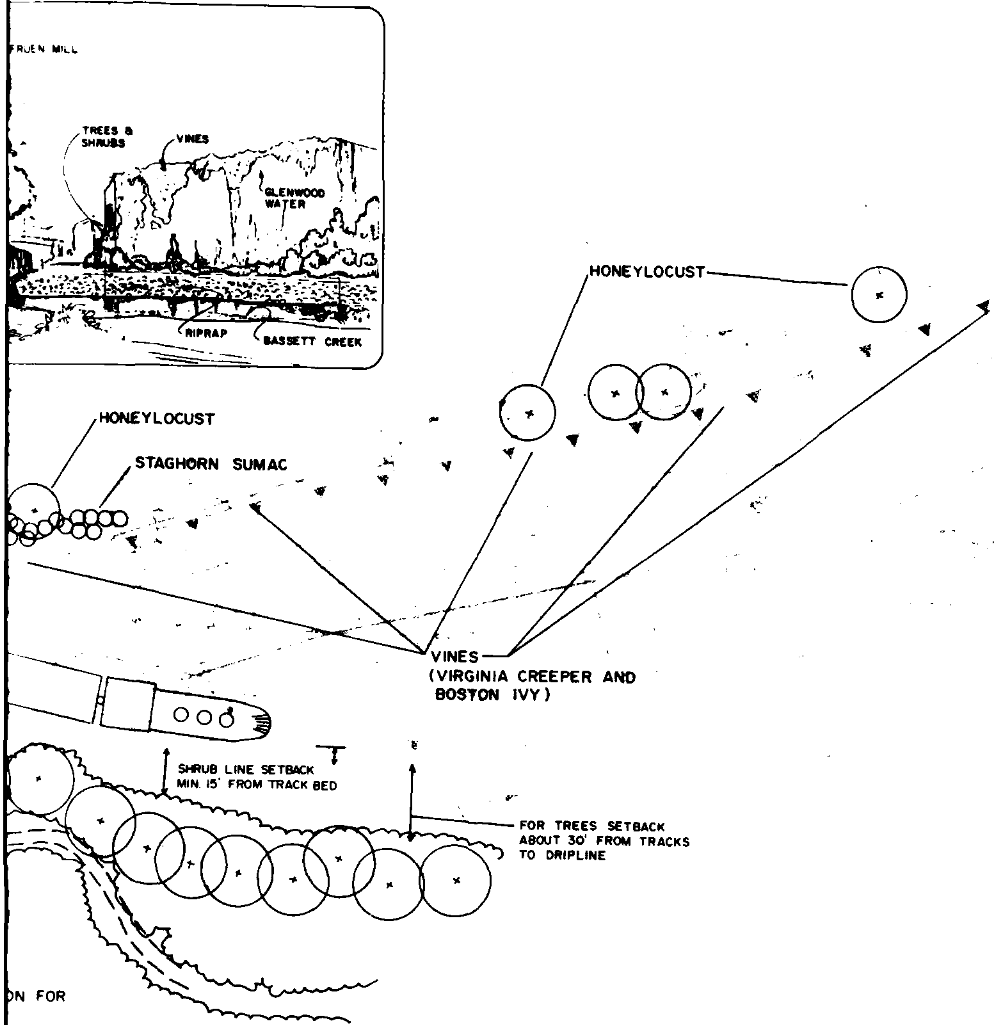

GREEN ASH AND
RED MAPLE
GREEN ASH
RED DOGWOOD AND
VIBURNUMS
RED MAPLE
HONEYSUCKLE,
RED DOGWOOD,
SMOOTH ALDER
GREEN
ASH
RED DOGWOOD, VIBURNUMS,
AND SMOOTH ALDER
HONEYSUCKLE
AND RED DOGWOOD
RED MAPLE
RED MAPLE
GREEN ASH
STRUCTURE
REGENT AVE NO
MINNAQUA AVE
GREEN ASH AND
RED MAPLE
GREEN ASH
RED DOGWOOD
RED DOGWOOD
CREEK
RED MAPLE
GREEN ASH
RED DOGWOOD
GREEN ASH AND
RED MAPLE
HONEYSUCKLE
CULVERT REPLACEMENT AT REGENT AVE
SAFETY PAYS
DEPARTMENT OF THE ARMY
ST PAUL DISTRICT CORPS OF ENGINEERS
ST PAUL, MINNESOTA
PHASE I DESIGN MEMORANDUM
FLOOD CONTROL BASSETT CREEK MINNESOTA
PENN AVE CULVERT REMOVAL HWY 55 CONTROL
STRUCTURE CULVERT REPLACEMENT AT NOBLE AVE
& CULVERT REPLACEMENT AT REGENT AVE NO
PLANTING PLANS
SUBMITTED BY
APPROVED
DATE
AUGUST 1982
AS SHOWN
SHEET OF

PLATE G-4


FRUEN MILL
TREES & SHRUBS
VINES
GLENWOOD WATER
RIPRAP
BASSETT CREEK


HONEYLOCUST
STAGHORN SUMAC
VEGETATIVE SCREEN
BUFFER TRACKS FROM TRAIL
SHRUB LINE SETBACK
MIN 15' FROM TRACK BED
RUSTIFICATION MEASURES TO BE
USED ON THIS CONCRETE WALL
TO MAKE IT FIT INTO SURROUND-
ING AREA (I.E. COLOR CONCRETE
AND PUT A FLAGSTONE WALL
TYPE FACE ON CONCRETE...)
OPEN SPACE
POSSIBLE LOCATION FOR
PARK BENCH
STONE BENCH
CLIFF FACE
SOME RE-ALIGNMENT OF THE
EXISTING TRAIL WILL BE
NEEDED
POSTS INSET INTO
GROUND 3' CONCRETE
REINFORCED
OBJECTIVE
REDUCE NEG VISUAL IMPACT
OF PLANNED SHEET PILE
RETAINING WALL AND PROVIDE
SAFETY RAILING
PLANT MATERIAL TO
REDUCE VISUAL
IMPACT OF IRON
SHEET PILES



NOTES:
1. OBJECTIVE OF PLANT MATERIALS HERE IS TO SOFTEN BUILDING EDGES, PROVIDE A VISUAL BARRIER FROM TRAIL USERS TO RAILROAD TRACKS, & LIMIT ERODABILITY OF LAND.
2. PLANT MATERIALS TO INCLUDE THE FOLLOWING: GREEN ASH, WHITE ASH, HONEYLOCUST, CRACK WILLOW, HONEYSUCKLE, DOGWOODS, SUMACS, VIBURNUMS, VIRGINIA CREEPER AND BOSTON IVY.

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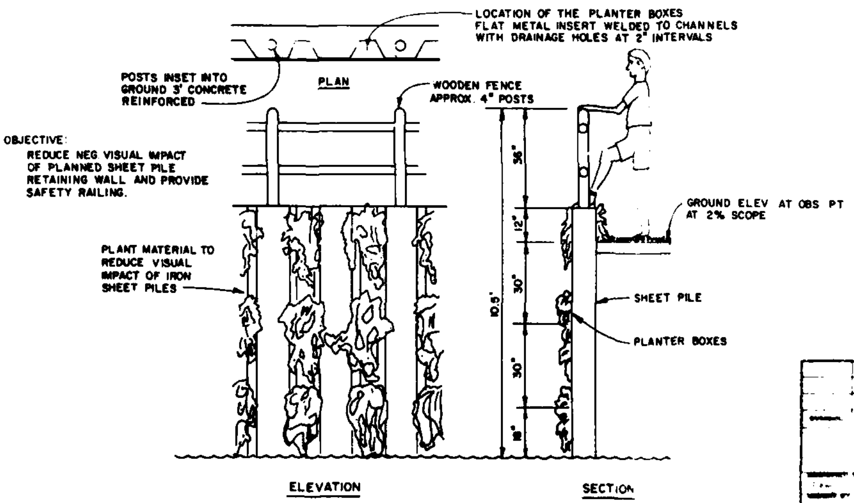

DEPARTMENT OF THE ARMY

SUBMITTED BY

APPROVED

DATE

DRAWING NUMBER

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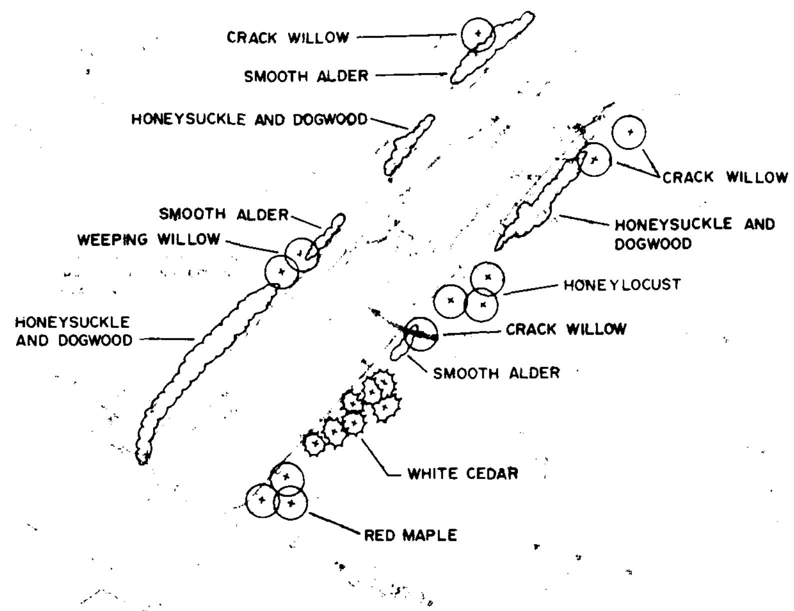
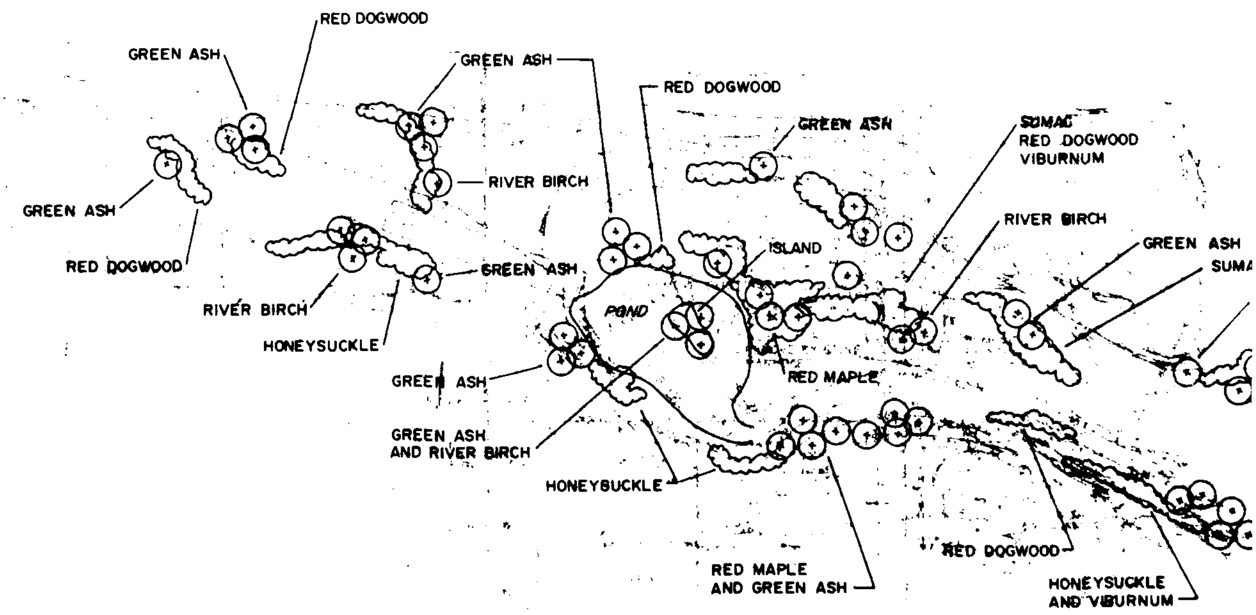
PLATE G-5


CRACK WILLOW
SMOOTH ALDER
HONEYSUCKLE AND DOGWOOD
CRACK WILLOW
SMOOTH ALDER
WEEPING WILLOW
HONEYSUCKLE AND DOGWOOD
HONEYSUCKLE AND DOGWOOD
HONEYLOCUST
CRACK WILLOW
SMOOTH ALDER
WHITE CEDAR
RED MAPLE


RED DOGWOOD
GREEN ASH
GREEN ASH
RED DOGWOOD
GREEN ASH
SUMAC
RED DOGWOOD
VIBURNUM
RIVER BIRCH
GREEN ASH
RED DOGWOOD
RIVER BIRCH
RIVER BIRCH
GREEN ASH
ISLAND
GREEN ASH
POND
HONEYSUCKLE
GREEN ASH
RED MAPLE
GREEN ASH
AND RIVER BIRCH
HONEYSUCKLE
RED DOGWOOD
RED MAPLE
AND GREEN ASH
HONEYSUCKLE
AND VIBURNUM

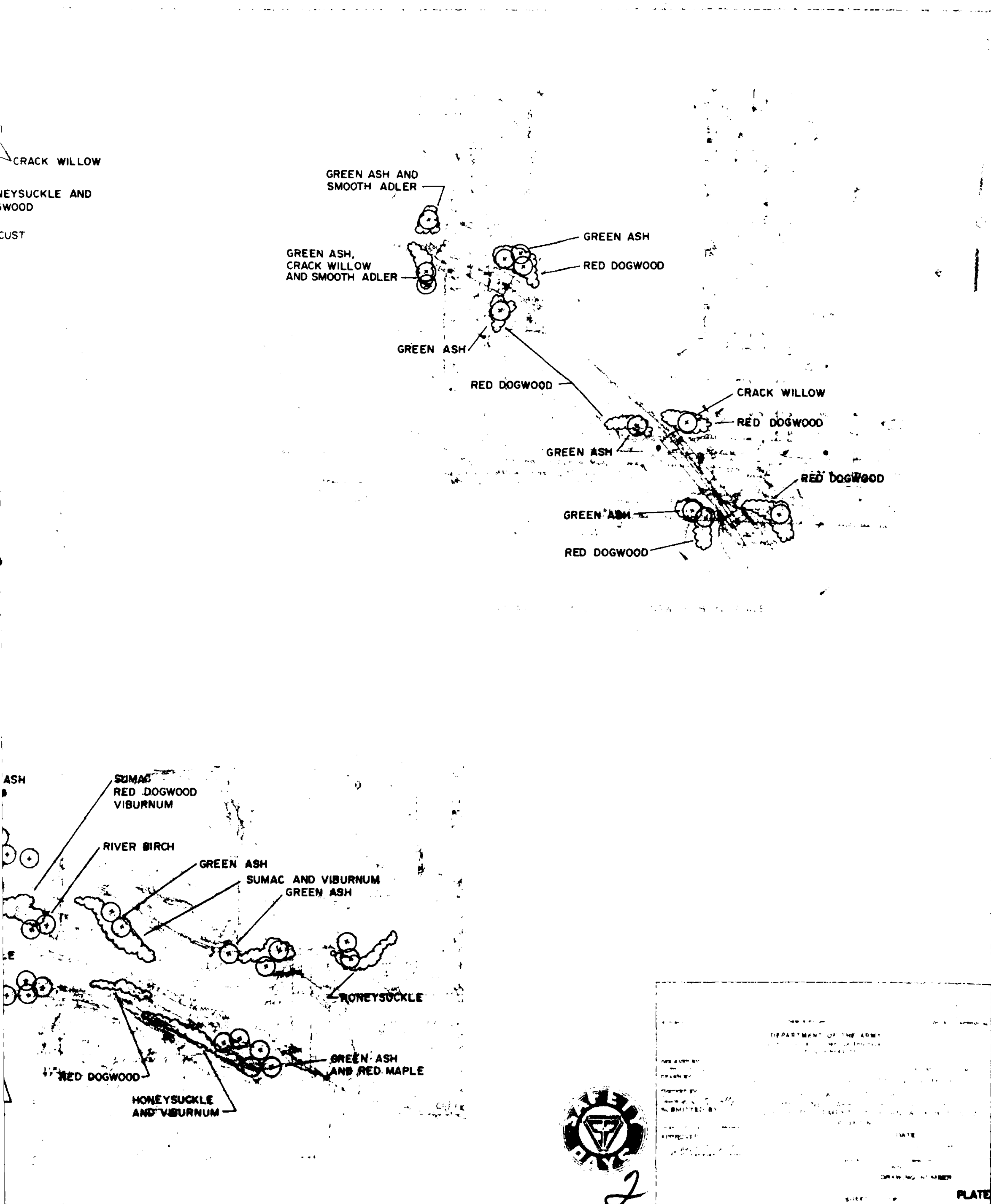

CRACK WILLOW
HONEYSUCKLE AND
DOGWOOD
CUST
GREEN ASH AND
SMOOTH ADLER
GREEN ASH
GREEN ASH,
CRACK WILLOW
AND SMOOTH ADLER
RED DOGWOOD
GREEN ASH
RED DOGWOOD
CRACK WILLOW
RED DOGWOOD
GREEN ASH
RED DOGWOOD
GREEN ASH
RED DOGWOOD
ASH
SUMAC
RED DOGWOOD
VIBURNUM
RIVER BIRCH
GREEN ASH
SUMAC AND VIBURNUM
GREEN ASH
HONEYSUCKLE
GREEN ASH
AND RED MAPLE
RED DOGWOOD
HONEYSUCKLE
AND VIBURNUM
DEPARTMENT OF THE ARMY
DATE
DRAWING NUMBER

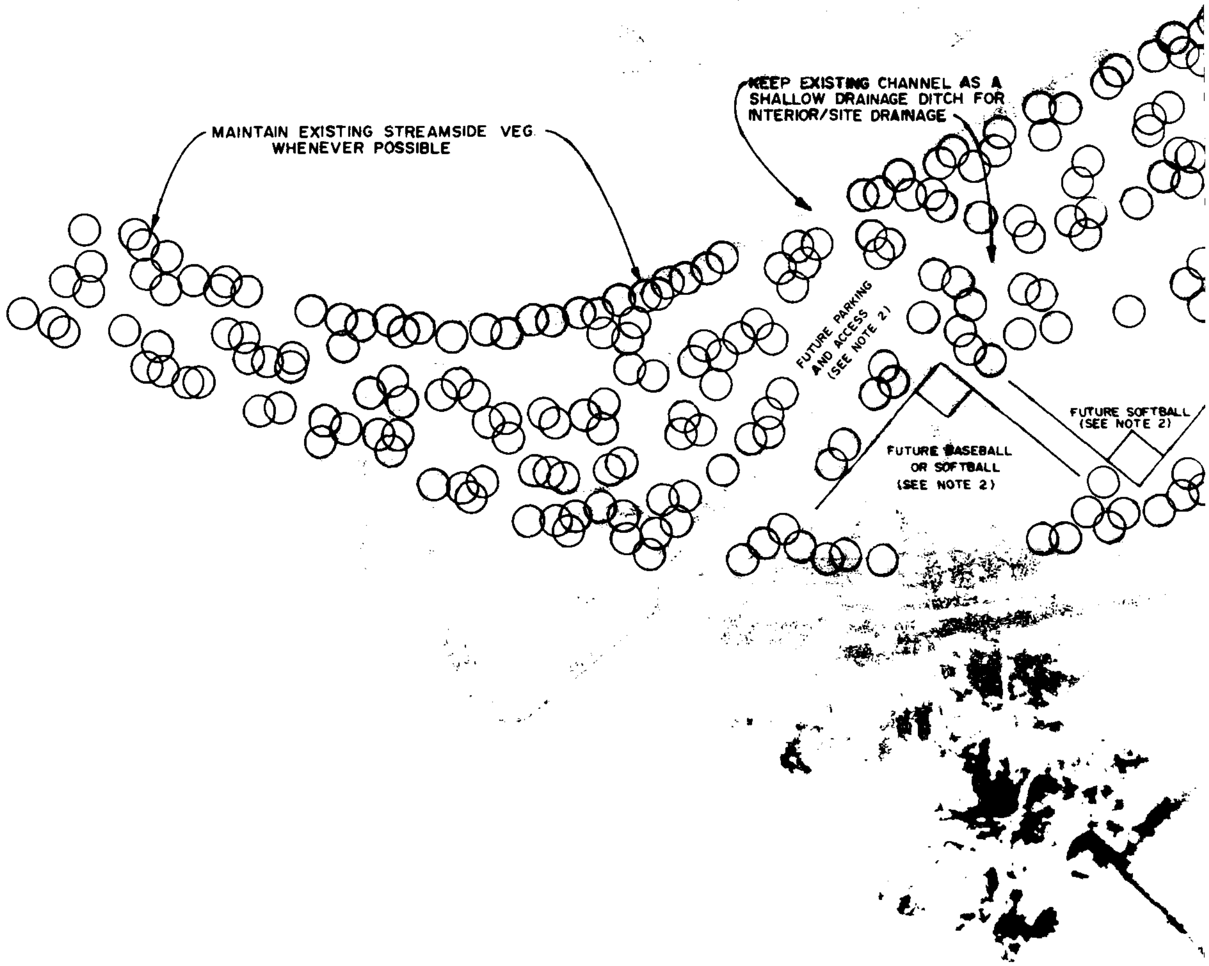
PLATE 6-6

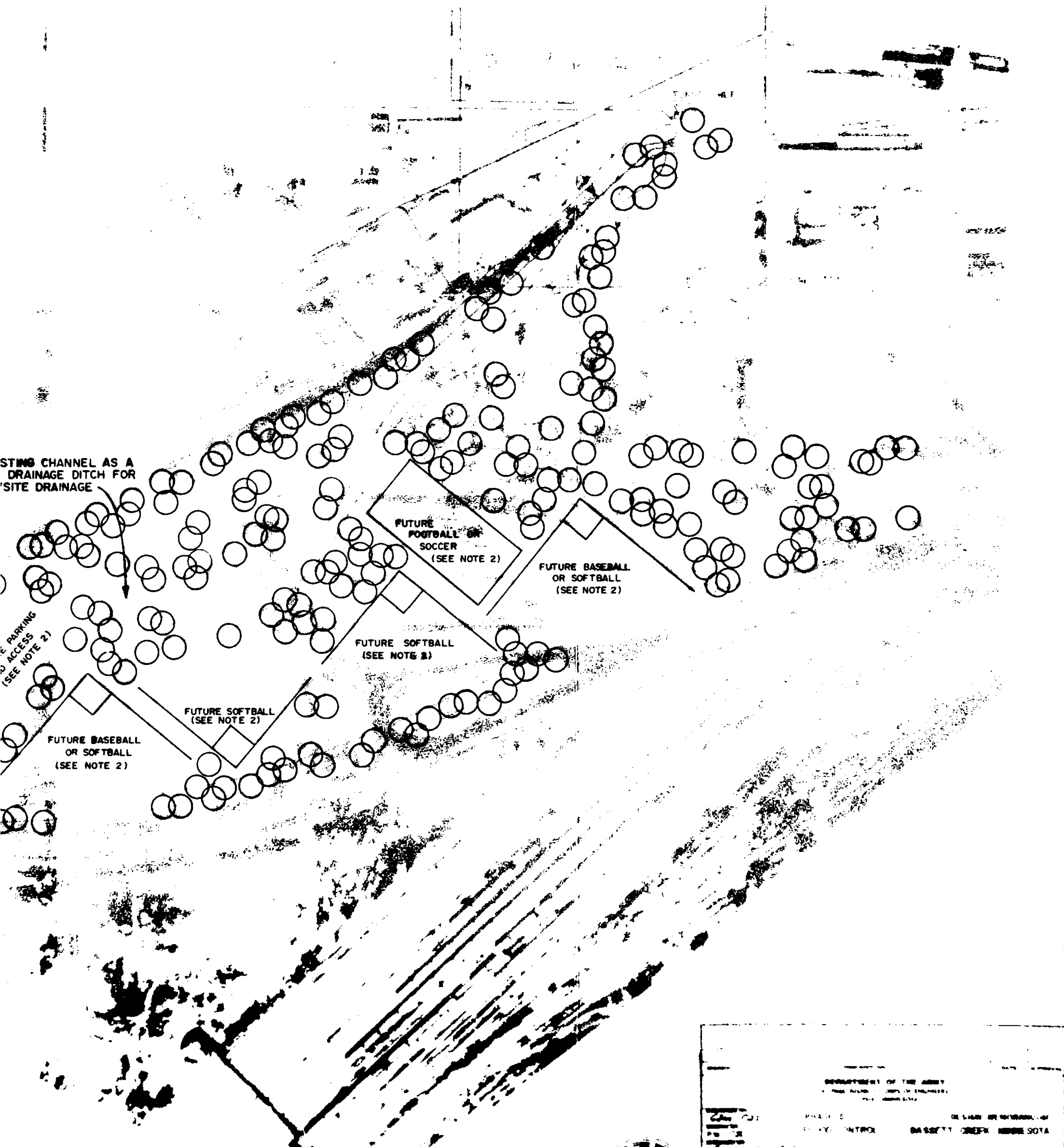
NOTES:

1. PLAN SHOWS ONLY NEW TREE PLANTINGS ACTUAL UNDERSTORY SHRUBS WILL ALSO BE INCLUDED AS PART OF THE FINAL PLANTING PLANS PREPARED FOR SPECIFICATIONS. PLANT SPECIES TO BE INCLUDED IN THIS AREA INCLUDE:

TREES			
GREEN ASH	HACKBERRY	RED DOGWOOD	VIBURNUM
RED MAPLES	WILLOW	STAGHORN SUMAC	HAZEL NUT
RIVER BIRCH	SILVER MAPLE	AMERICAN PLUM	
RED CEDAR	WHITE CEDAR	HONEYSUCKLE	

2. ALL RECREATION FEATURES SHOWN ARE A FUTURE NON-FEDERAL RESPONSIBILITY (I.e. NO RECREATION IS INCLUDED AS A PART OF THIS PROJECT).





DEPARTMENT OF THE ARMY

PHASE 2

FLOOD CONTROL BASSETT CREEK MINNESOTA

PROPOSED INTERIOR FLOOD CONTROL FEATURES

BERMED AREA BY CONDUIT ENTRANCE

DATE AUGUST 1982

2

SHEET OF

PLATE 0-7

DEPARTMENT OF THE ARMY
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX H

FLOODPROOFING

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H-48, H-49	2505, 2545 REGENT AVENUE NORTH
H-50 - H-53	3810 BASSETT CREEK DRIVE
H-54 - H-56	3820 BASSETT CREEK DRIVE
H-57	3810 AND 3820 BASSETT CREEK DRIVE
H-58 - H-61	4975 BASSETT CREEK DRIVE
H-63 - H-65	5005 BASSETT CREEK DRIVE
H-66, H-67	5110, 5120, 5126 MINNAQUA DRIVE
H-68 - H-70	5125 MINNAQUA DRIVE
H-71, H-72	5222 MINNAQUA DRIVE
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APPENDIX H

FLOODPROOFING

GENERAL

1. The 1976 Feasibility Report noted that approximately 20 residential dwellings were located along Bassett Creek which could not be afforded 100 year flood protection by the major structural project features. It was determined that adverse environmental impacts were minimized and project economics were best served by providing a nonstructural floodproofing program for these residences.

2. As a result of post authorization hydrology and hydraulic design studies, it was determined that 24 houses along Bassett Creek would need protection against the 100-year event. These 24 homes form the project's nonstructural floodproofing program.

ALTERNATIVES CONSIDERED

3. In general, three basic alternatives for flood-proofing were considered for each of the 24 residences. The first alternative consists of construction of a low earth berm between the home and the creek to a flood protection elevation (Regulatory Flood Datum) 1-foot above the proposed 100-year flood level. An interior drainage system would have to be provided within the bermed area to handle local storm water runoff.

4. The second alternative considered consists of closing low openings and providing earth fill against the home foundation to prevent entry of flood waters to an elevation of 1-foot above the proposed 100-year flood level. With this alternative, a system of drain tile would be installed to prevent undesirable uplift and seepage pressures on the existing basement floor.

5. The third alternative basically consists of raising the home to 1-foot above the proposed 100-year flood level at its existing location and on its existing foundation. The home would be separated from its existing foundation and the existing foundation would be extended upward to the flood protection elevation and the house would be replaced on its new foundation.

6. In addition, variations of the second alternative were considered, including use of retaining walls around patio areas with interior drainage facilities, use of small landing wells at door openings to avoid losing direct access to the yard via the walk-out and the use of window wells around low windows to prevent blocking openings required to maintain legal emergency exits for living and sleeping quarters.

APPROACH TO THE PROBLEM

7. In 1979, under a Section 215 agreement (see Section 215, P.L. 90-483), Barr Engineering Co., for the city of Golden Valley, began design for the floodproofing program. Affected residents were informed that the city of Golden Valley had adopted a policy requiring each identified residence to conform to recently adopted flood plain management regulations. Non-conforming uses were no longer acceptable for residential structures.

8. On 29 November 1979, a public workshop meeting was held at the Golden Valley City Hall for the purpose of discussing the concept of flood-proofing and the proposed schedules for flood-proofing residential dwellings in the project area. Each of the affected homeowners was individually notified by mail in advance of the meeting and approximately half of the homeowners were able to attend the meeting. Following the November 29 meeting, a series of meetings were held with each homeowner. This series of meetings presented to each home-owner a reiteration of the material discussed on 29 November 1979, and discussed their particular situation and their particular home. The meetings were held in the homes requiring flood-proofing and, thus, an on-site inspection of each property was a part of each meeting. Photographs of each home were obtained to facilitate the design of the flood-proofing measures and to provide a record of the before condition.

9. Following the meeting with each individual homeowner, the needs of each home were evaluated based upon the economical and technical aspects of protecting that property. During this review period, the desires and concerns of each homeowner were also considered.

ANALYSIS OF THE PROBLEM - FIRST GROUP

10. The City of Golden Valley presented 4 separate design submittals analyzing the flooding problems of homes grouped by area or with similar problems.

11. The first design submittal discussed the concerns, needs and solutions for flood-proofing of four homes in the city of Golden Valley along the Main Stem of Bassett Creek. Due to the unique requirements of these 4 homes, the analysis, discussion and recommendations are being presented as the first floodproofing group of residences. These homes are located just east of T.H. 100 along Scott Avenue North. The addresses are:

2605 Scott Avenue North

2655 Scott Avenue North

2665 Scott Avenue North

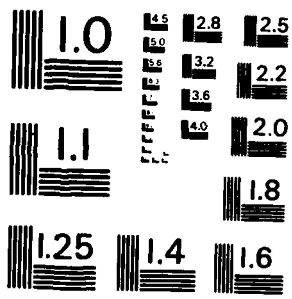
2675 Scott Avenue North

12. These adjoining homes are located just north of the Main Stem of Bassett Creek and each of the homes has been subject to flood damage in the past. The most recent occurrence of flood damage was in July, 1978, when these homes had from 6 inches to more than 2 feet of water in the lower levels of each home. The low openings in these homes are from 1 foot to approximately 2.5 feet below the proposed 100-year flood level in this area. The proposed 100-year flood level is approximately 2.5 to 3 feet below the existing 100-year flood level in this area. Two of the homes have built low level retaining walls around patio areas at the rear of the home in an effort to prevent frequent flood damage. The elevations of these retaining walls are inadequate to prevent flood damage by a flood approaching the 100-year flood event and are obviously structurally inadequate to provide long-term flood protection for the residences. The garage doors are all below the proposed 100-year flood level in this area and since Scott Avenue is inundated by backwater from the Main Stem of Bassett Creek, flood waters can enter the homes through the garage door and this has occurred in the past.

AD-A133 795 BASSETT CREEK WATERSHED HENNEPIN COUNTY MINNESOTA FEASIBILITY REPORT FOR FLOOD CONTROL MAIN REPORT(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 82

6/9

UNCLASSIFIED F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SOIL CONDITIONS - FIRST GROUP

13. Each of the homes is constructed on piling, which are typically approximately 60 feet long. Copies of the piling layout and lot description were prepared. To facilitate technical review of the alternatives considered for each home, a series of hand auger soil borings were obtained in the vicinities of the four homes. These hand soil borings obtained a maximum depth of approximately 15 feet. For these four homes being considered, the soil borings uniformly reflected a thin topsoil layer, a layer of black peat and a layer of olive color muck containing organic debris and snail shells. Occasional thin sand lenses were evident in some of the soil borings near the surface and it is unknown if these are natural deposits or sand fill which remained after home construction.

14. Based upon the adverse soil conditions which exist in the area of the first four homes, it was determined that it would be impractical to attempt to build earth berms or retaining walls at these locations. It was also determined that the closing of low openings and the embankment of earth material against the home was impractical in these locations due to the adverse soils, the need for a concrete block basement wall, and the prospect of fairly large earth settlement in the future. Further, the individual homeowners in each case strongly desired to keep the walkout lower level.

RECOMMENDATIONS - FIRST GROUP

15. Based upon the above discussion, it is recommended that the four homes at 2605, 2655, 2665 and 2675 Scott Avenue North, in the city of Golden Valley, be raised to an elevation of not less than 1 foot above the proposed 100-year flood level in this area. With one exception, the elevation of the garage slabs would remain the same. The garages would be subject to inundation during a 100-year flood, however, the garages would be free-draining as the flood waters receded. At 2665 Scott, however, the existing garage slab is approximately 2 feet below street grade and would not be freedraining following a flood. It is, therefore, recommended that the garage slab be reconstructed at an elevation above street level as part of the raise. Modifications to each home are presented by address on pages H-4 through H-7.

BASSETT CREEK FLOODPROOFING
SPECIFIC RECOMMENDATIONS

THE BRECKENRIDGE RESIDENCE LOCATED AT 2605 SCOTT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA: THE SOIL CONDITIONS AND TOPOGRAPHY WILL NOT ALLOW EITHER THE CONSTRUCTION OF A WALL OR A BERM AS A MEANS OF FLOODPROOFING THIS STRUCTURE. THE BEARING POTENTIAL OF THE SOIL REQUIRES PILING TO SUPPORT A WALL. THE LACK OF TOPOGRAPHY AND CLOSE PROXIMITY TO THE CREEK ELIMINATES BERMING AS A SOLUTION.

WE RECOMMEND RAISING THIS RESIDENCE AS A MEANS OF FLOODPROOFING. THE LEVEL OF THE LOWER LEVEL FLOOR IS 1.64 FT. BELOW THE ONE HUNDRED YEAR FLOOD LEVEL OF 843.2 FT. THE LOWER LEVEL OF THE HOME IS COMPLETELY FURNISHED WITH FIREPLACES ON EACH LEVEL. THE STRUCTURE WILL BE RAISED TO A LEVEL OF 844.75 FT. WHICH WILL RESULT IN A LEVEL ONE FOOT ABOVE THE ONE HUNDRED YEAR FLOOD LEVEL. THE GARAGE WILL REMAIN AT THE EXISTING LEVEL TO ELIMINATE THE NEED FOR THE CONSTRUCTION OF AN EXPENSIVE FLOOR SLAB.

WE ALSO RECOMMEND THE CONSTRUCTION OF A RIPRAP WALL ON THE BANK OF THE CREEK TO ELIMINATE EROSION OF THE SOIL AT THE BEND IN THE CREEK.

SEE PLATES H-1 THROUGH H-9.

SUMMARY OF ELEVATIONS:

BACK DOOR SILL	842.31
WINDOW SILL	845.50
FIRST FLOOR	850.48
SIDE DOOR	842.17
GARAGE DOOR	842.11

CONSTRUCTION ESTIMATE:
2605 SCOTT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA

CARPENTRY	$20,100.00
MASONRY	
BLOCK	4,000.00
ELECTRICAL	700.00
PLUMBING	3,400.00
HVAC	2,700.00
HOME RAISE	10,100.00
CRIBBING AT EMBANKMENT	2,000.00
PERMITS & PLAN CHECK	300.00
	100.00
TOTAL ESTIMATE	$43,400.00

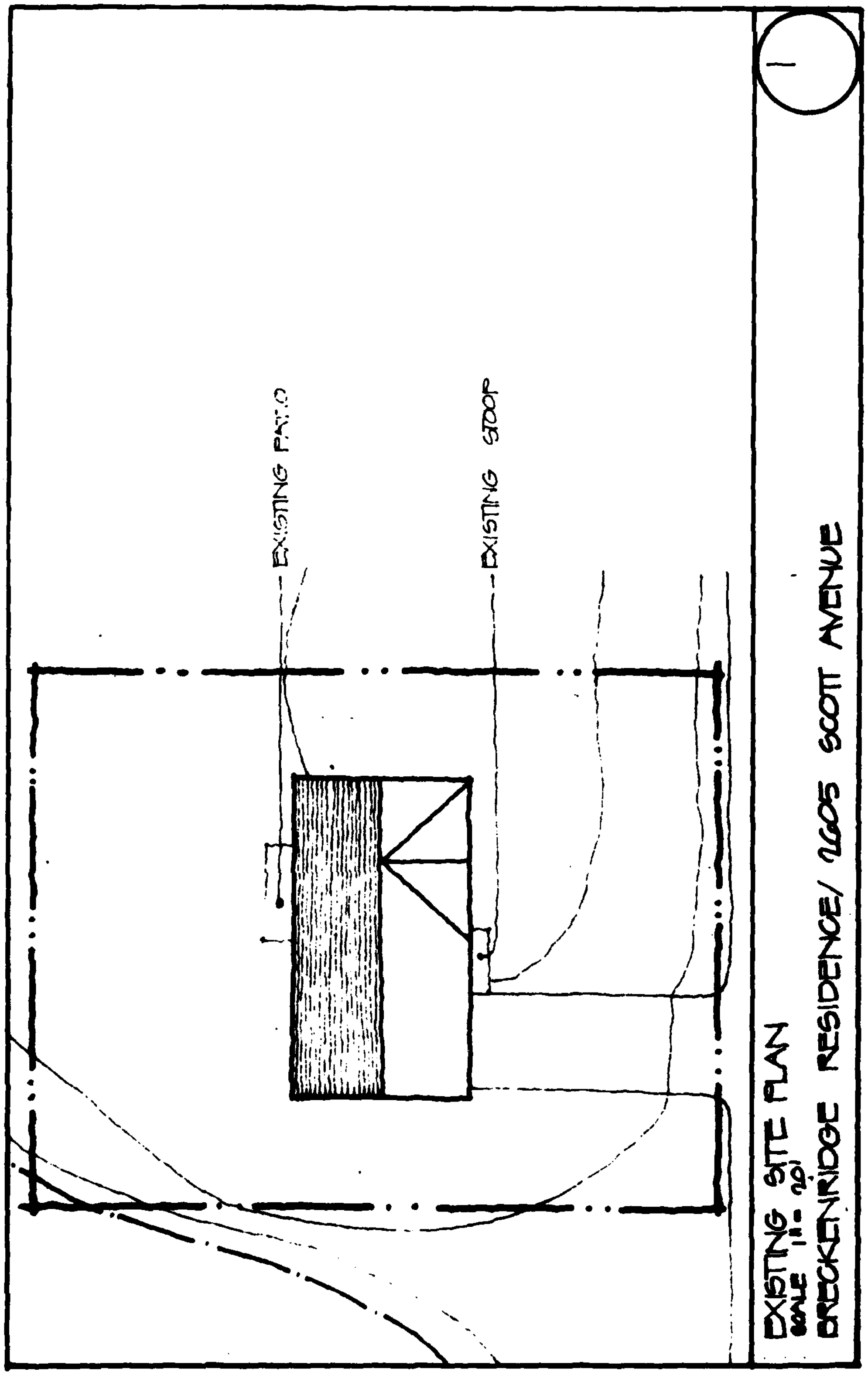
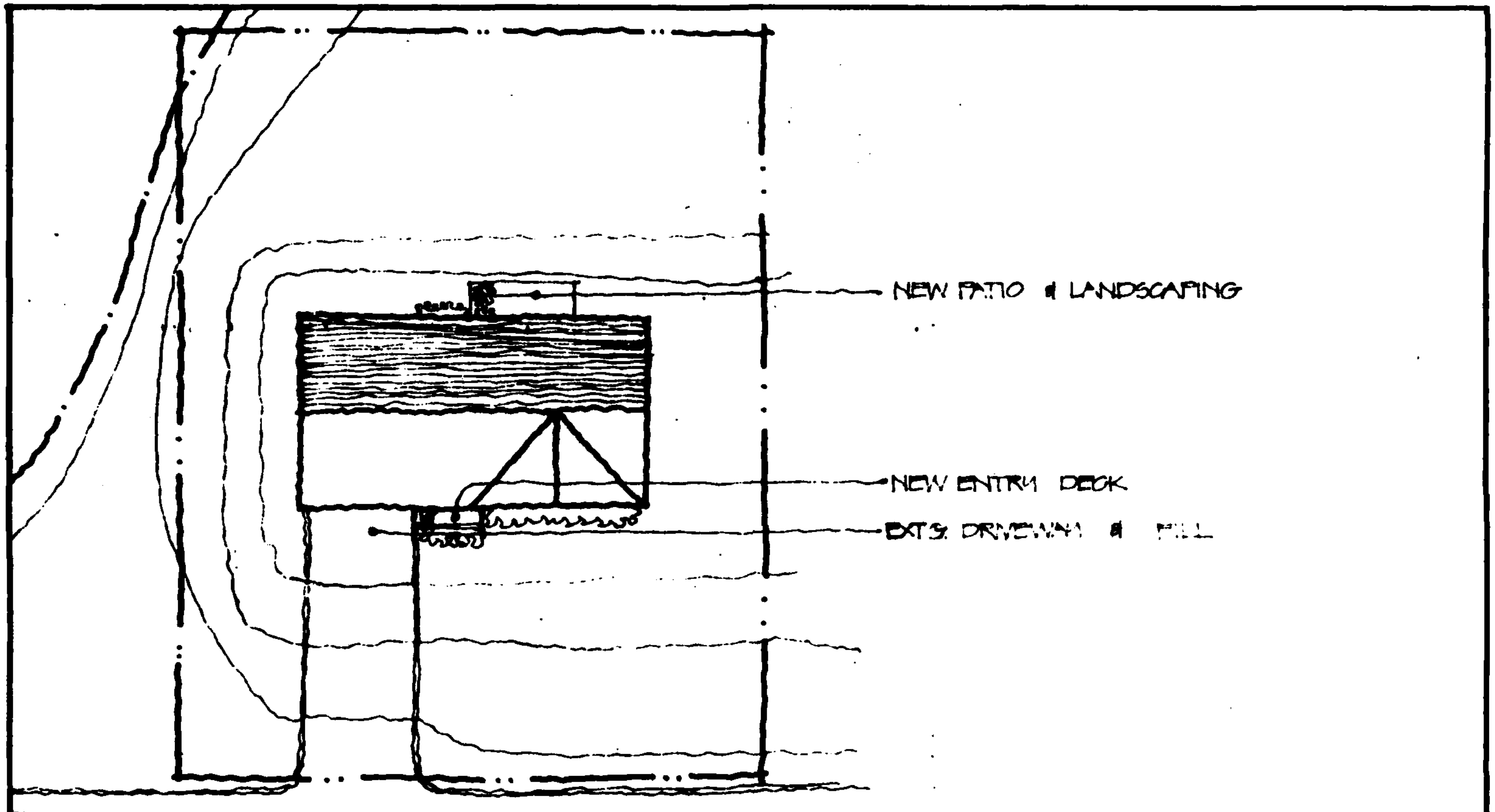

EXISTING PATIO
EXISTING STOOP
EXISTING SITE PLAN
SCALE 1" = 20'
BRECKENRIDGE RESIDENCE/ 2605 SCOTT AVENUE

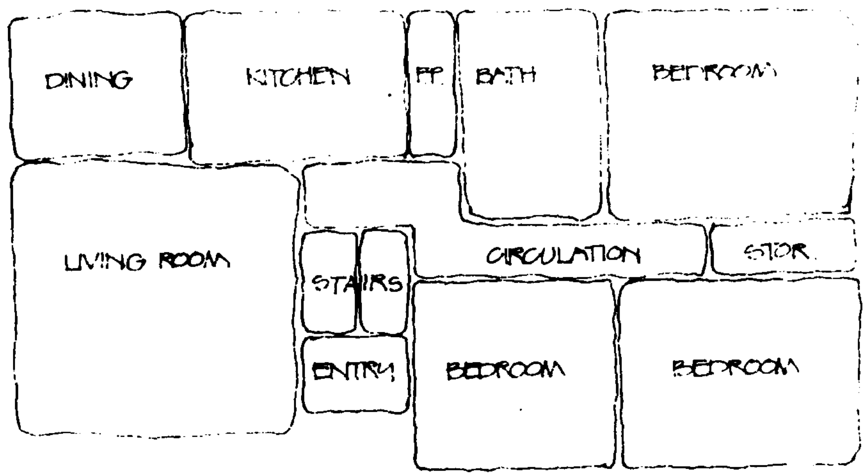
PLATE H-1



PROPOSED SITE PLAN
SCALE 1" = 20'
BRECKENRIDGE RESIDENCE / 2605 SCOTT AVENUE

2

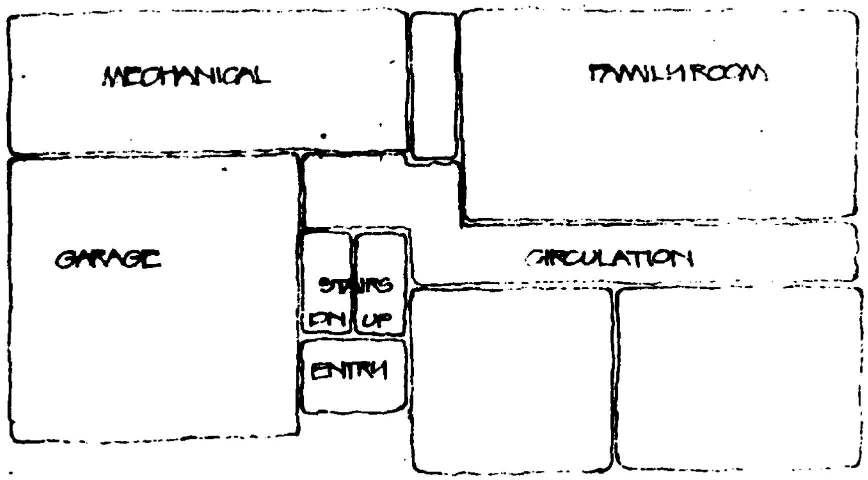
PLATE 7H-2



SCHEMATIC FLOOR PLAN / UPPER LEVEL
SCALE : 1/8" = 1'-0"
BRECKENRIDGE RESIDENCE/2608 SCOTT AVENUE

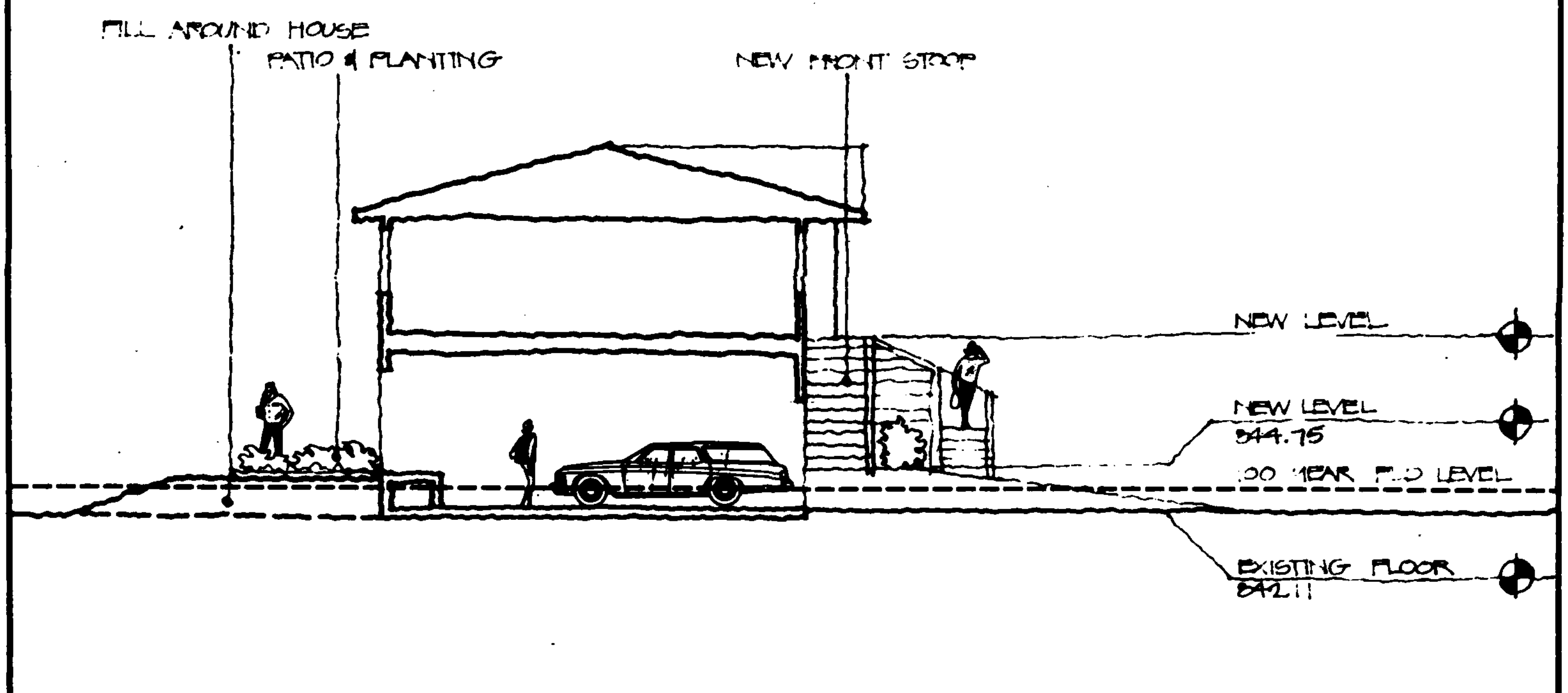
3

PLATE H-3



SCHEMATIC FLOOR PLAN / LOWER LEVEL
SCALE: 1/8" = 1'-0"
BRECKENRIDGE RESIDENCE / 1608 SCOTT AVENUE

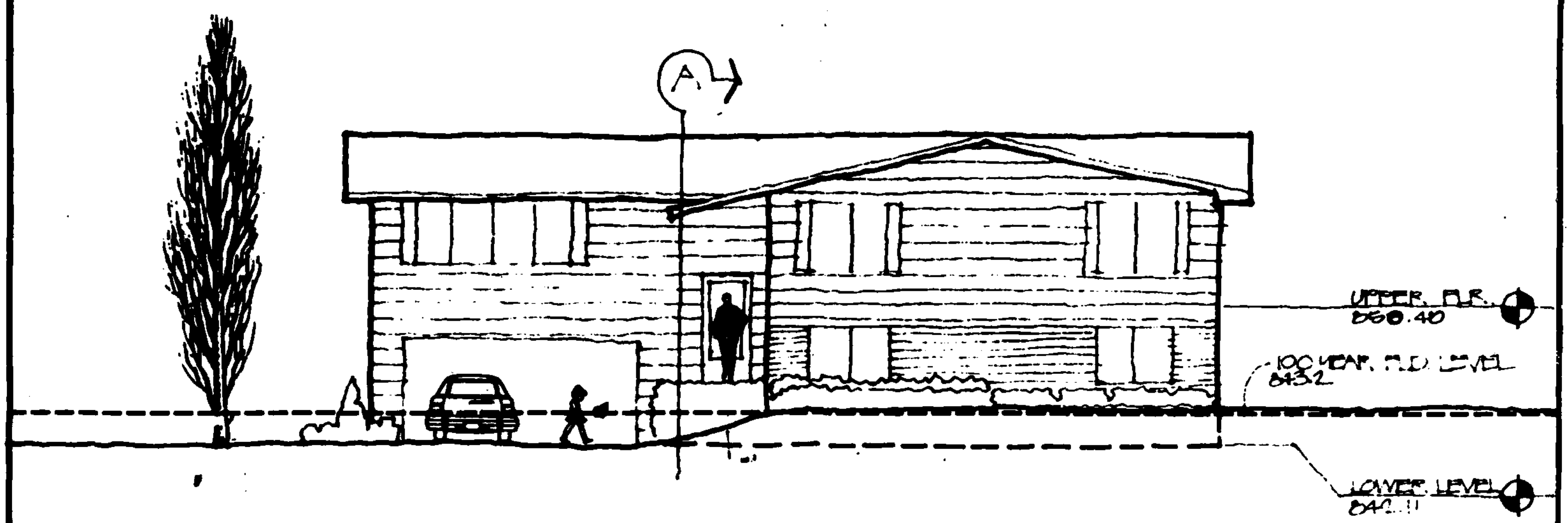
4



PROPOSED SECTION
SCALE 1/8" = 1'-0"
BRECKENRIDGE/RESIDENCE 2605 SCOTT AVENUE

5

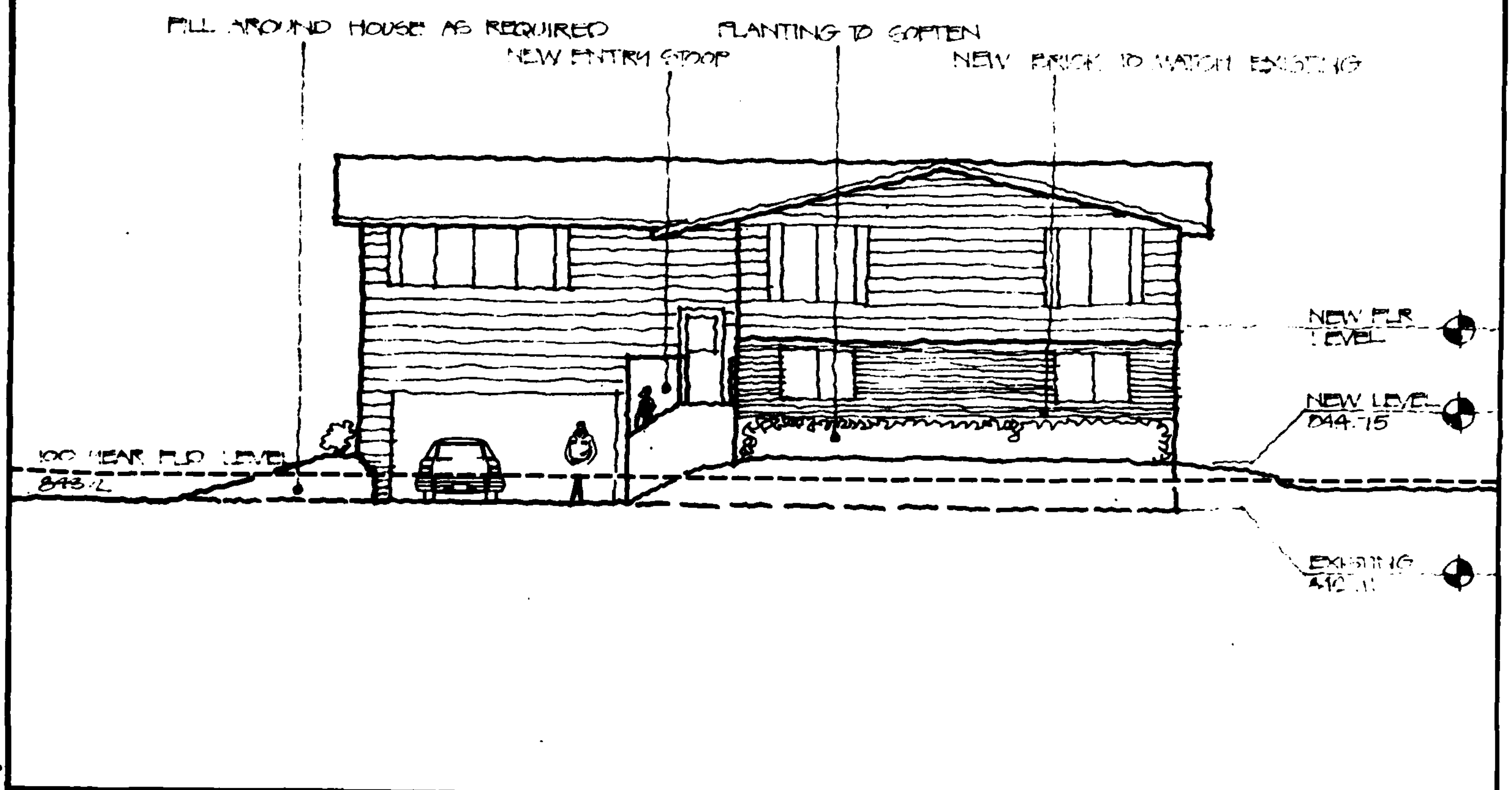
PLATE H-5



EXISTING FRONT ELEVATION
SCALE : 1/8" = 1'-0"
BRECKENRIDGE RESIDENCE/ 2605 SCOTT AVENUE

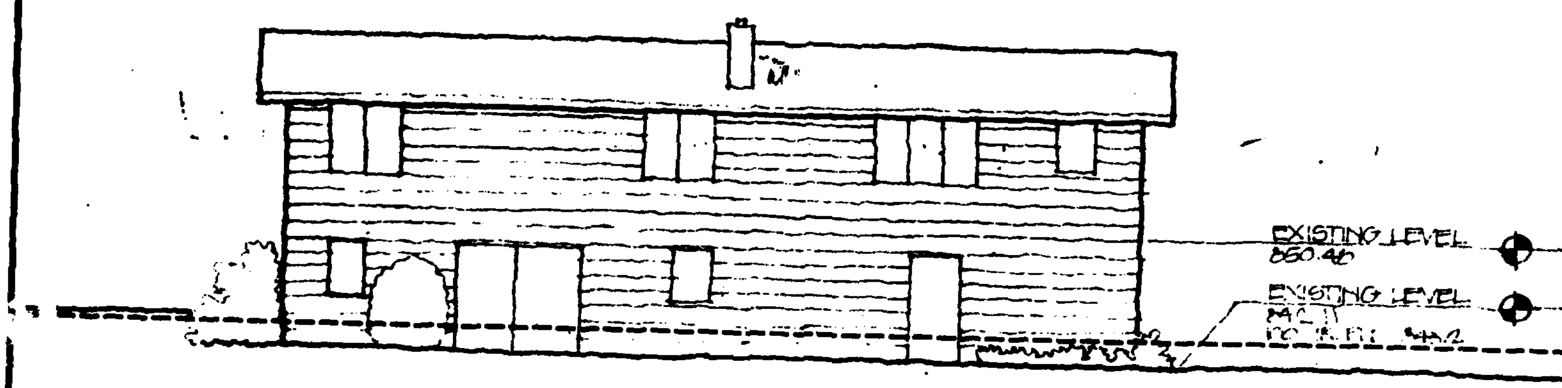
6

PLATE H-6 H-6



PROPOSED FRONT ELEVATION
SCALE: 1/8" = 1'-0"
BRECKENRIDGE RESIDENCE / 2605 SCOTT AVENUE

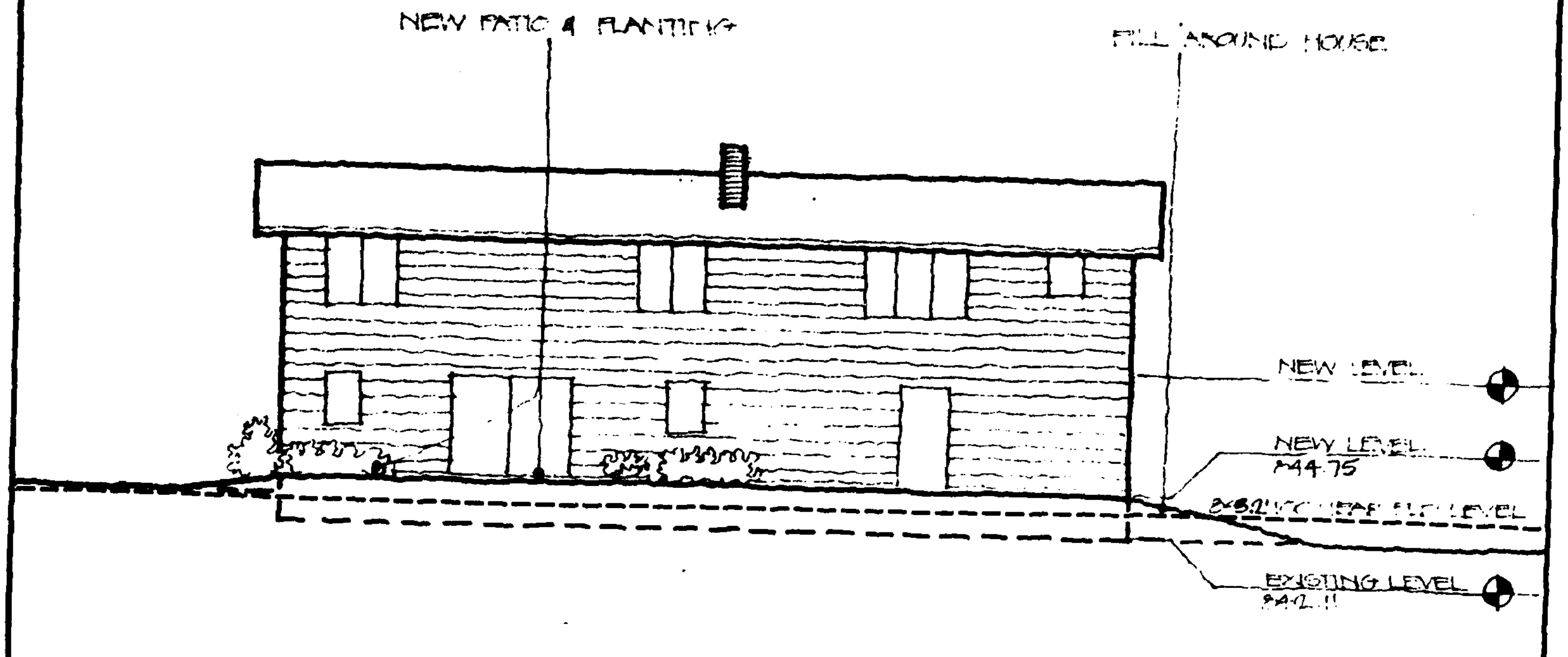
PLATE H-7



EXISTING REAR ELEVATION
SCALE: 1/8" = 1'-0"
BRECKENRIDGE RESIDENCE / 2605 SCOTT AVENUE

8

PLATE H-8



PROPOSED REAR ELEVATION
SCALE: 1/8" = 1'-0"
BRECKENRIDGE RESIDENCE / SCOTT AVENUE

9

PLATE H-9

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE MCGOWAN RESIDENCE LOCATED AT 2655 SCOTT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA: THE MCGOWANS HAVE EXPERIENCED FLOODING MOST RECENTLY IN THE 1976 FLOOD. PHOTOS OF THE FLOOD OF 1976 WERE TAKEN BY THE MCGOWANS. THE FLOOD WATERS ENTERED THE HOME THROUGH THE GARAGE. THE RESIDENCE IS 1.64 FT. BELOW THE ONE HUNDRED YEAR FLOOD LEVEL. THE GROUND FLOOR OF THE HOME IS ON THE SAME LEVEL AS THE GARAGE FLOOR.

THE RECOMMENDATION OF THIS STUDY IS THAT THE HOME BE RAISED TO A LEVEL OF ONE FOOT ABOVE THE ONE HUNDRED YEAR FLOOD LEVEL. WE RECOMMEND THE HOME BE RAISED, BUT THAT THE GARAGE REMAIN AT THE EXISTING LEVEL. THIS IS DUE TO THE POOR SOIL CONDITIONS WHICH INCREASE THE PROBLEM OF RAISING THE GARAGE FLOOR. WE FEEL THAT THE PILINGS WOULD PUSH THROUGH THE GARAGE FLOOR UNLESS WE SIGNIFICANTLY INCREASED THE STRUCTURAL CAPACITY OF THE FLOOR. THIS WOULD BE COST PROHIBITIVE AND NOT NECESSARY TO THE FLOOD-PROOFING OF THE RESIDENCE. THE GARAGE WILL NECESSARILY FLOOD DURING HIGH WATER CONDITIONS.

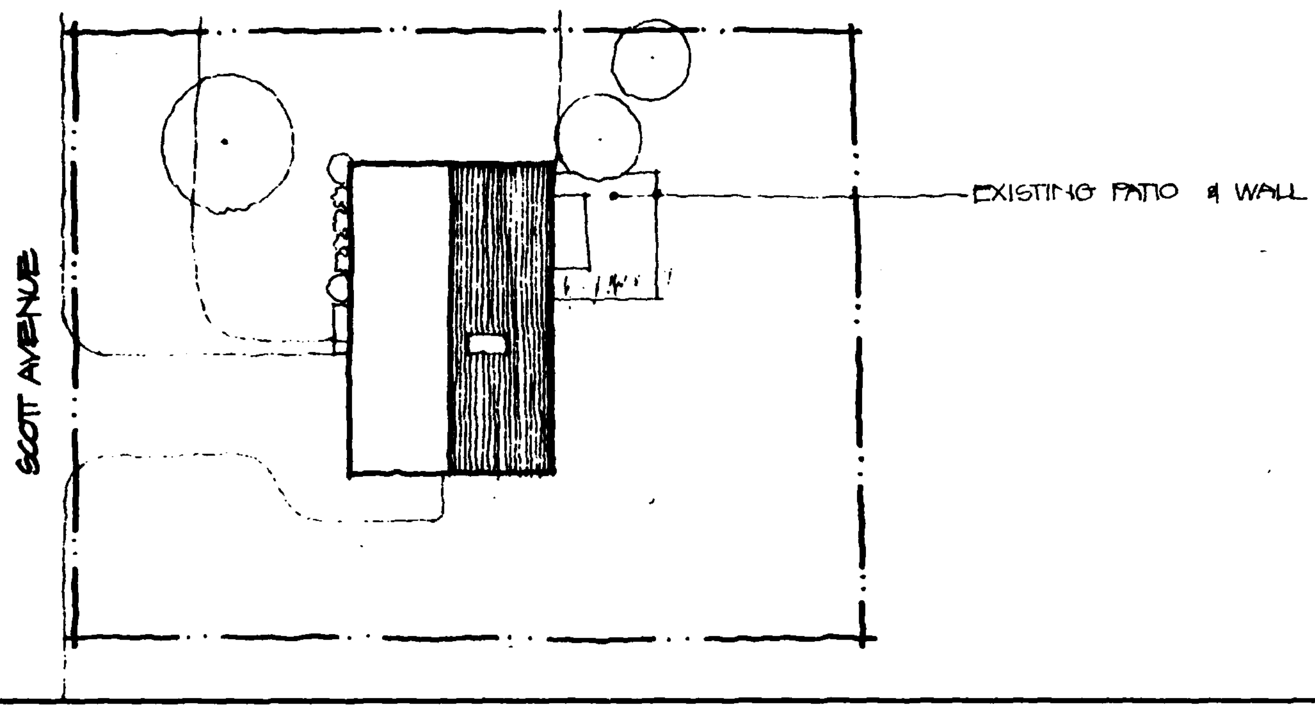
SEE PLATES H-10 THROUGH H-18.

SUMMARY OF ELEVATIONS:

SLIDING DOOR @ PATIO	842.12
WINDOW SILL	845.65
PATIO WALL	842.16
DOOR SILL	842.28
SIDE DOOR GARAGE	842.08
FIRST FLOOR	850.08

CONSTRUCTION ESTIMATE:
2655 SCOTT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA

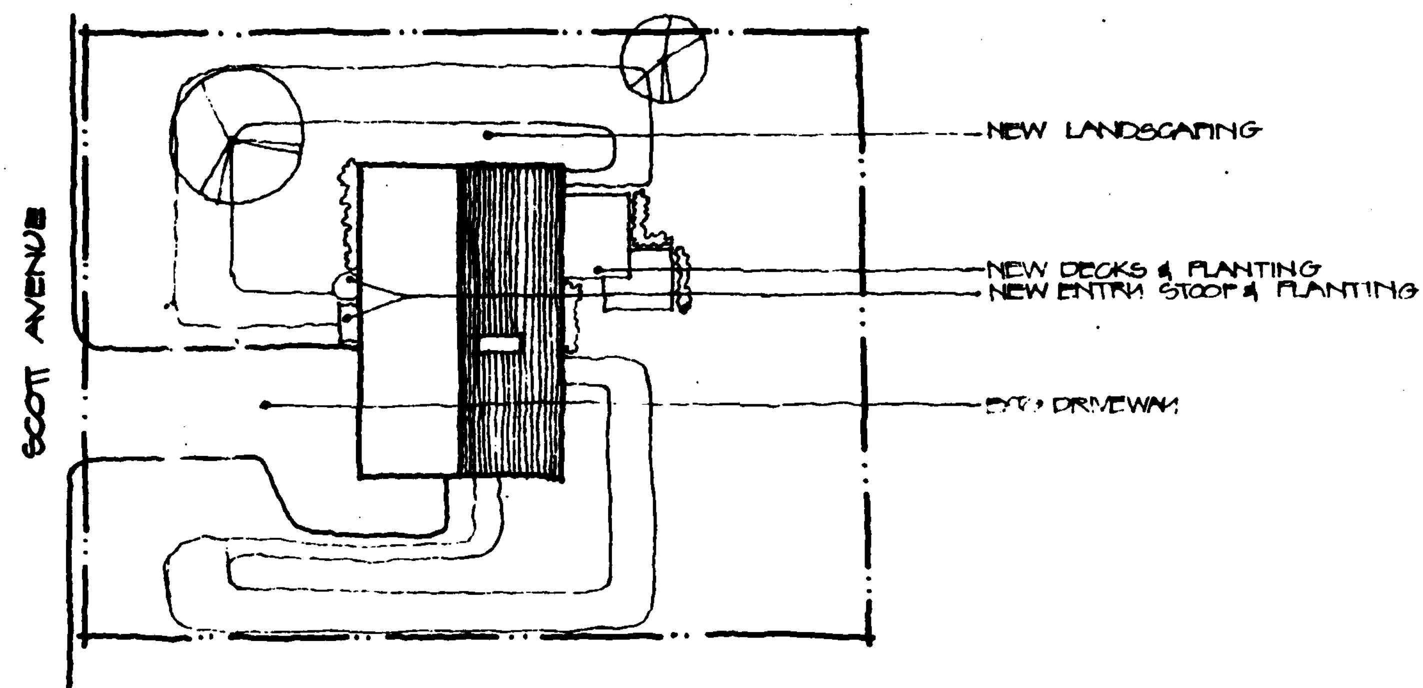
CARPENTRY	$20,000.00
MASONRY	
BLOCK	4,000.00
ELECTRICAL	500.00
PLUMBING	3,800.00
HVAC	2,700.00
HOME RAISE	10,100.00
PERMITS & PLAN CHECK	300.00
	100.00
TOTAL ESTIMATE	$41,500.00



EXISTING SITE PLAN
SCALE: 1" = 20'
McGOWAN RESIDENCE, 2658 SCOTT AVENUE

1

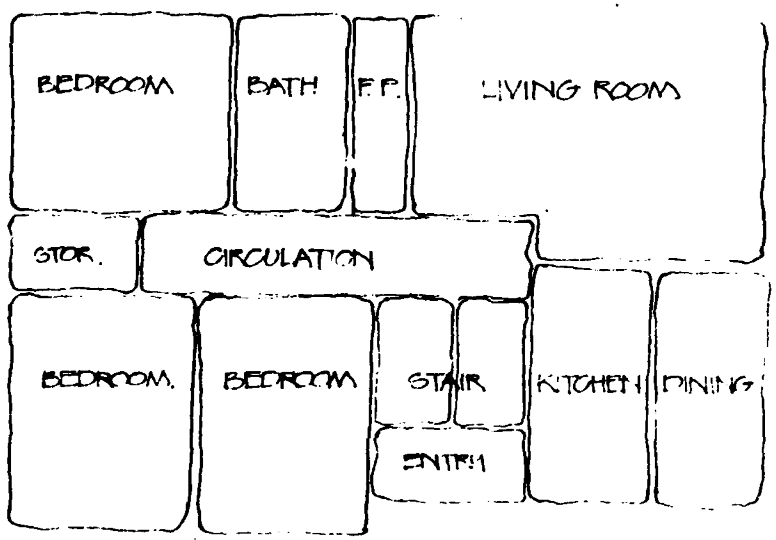
PLATE H-10



PROPOSED SITE PLAN
SCALE : 1" = 20'
McGOWAN RESIDENCE / 2655 SCOTT AVENUE

2

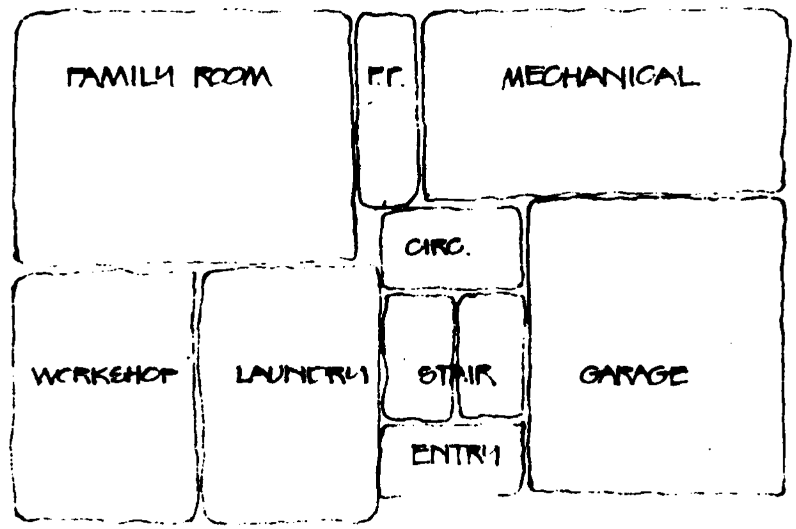
PLATE H-II



SCHEMATIC FLOOR PLAN / UPPER LEVEL
SCALE : 1/8" = 1'-0"
McGOWAN RESIDENCE, 1655 SCOTT AVENUE

3

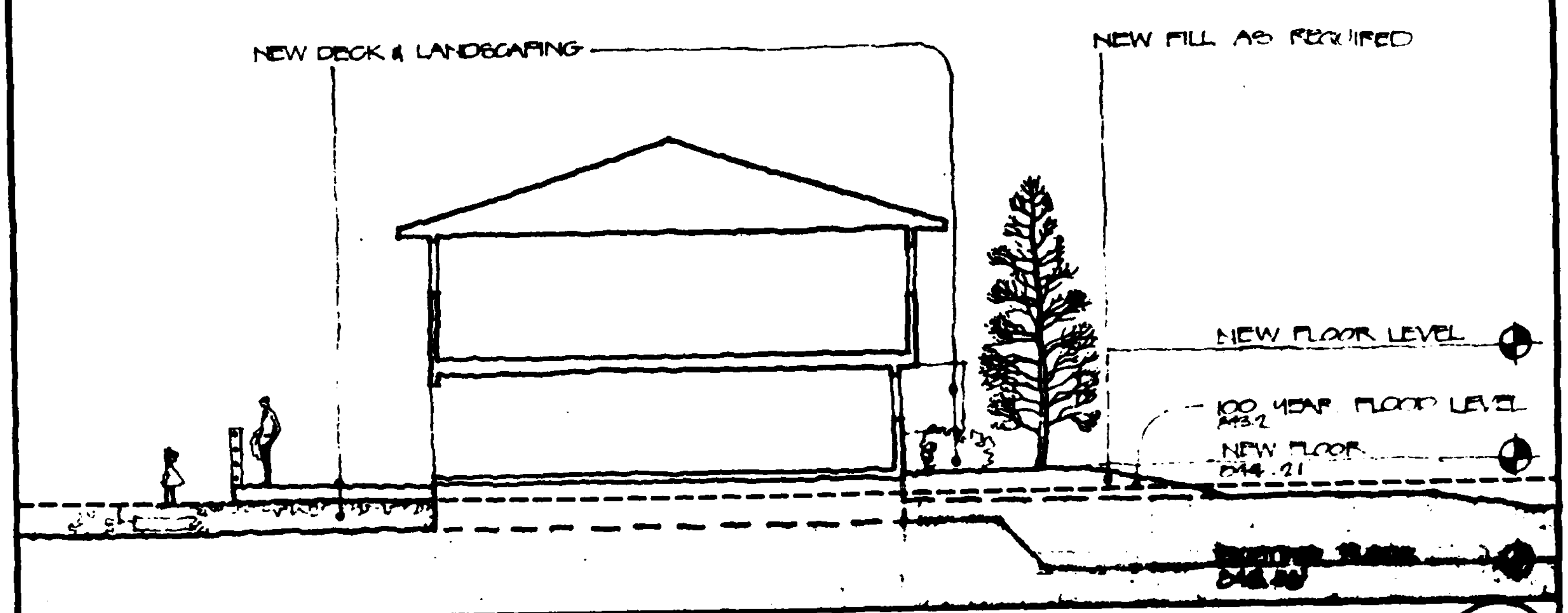
PLATE H-12



SCHEMATIC FLOOR PLAN / LOWER LEVEL
SCALE: 1/8" = 1'-0"
McGOWAN RESIDENCE, 2655 SCOTT AVENUE

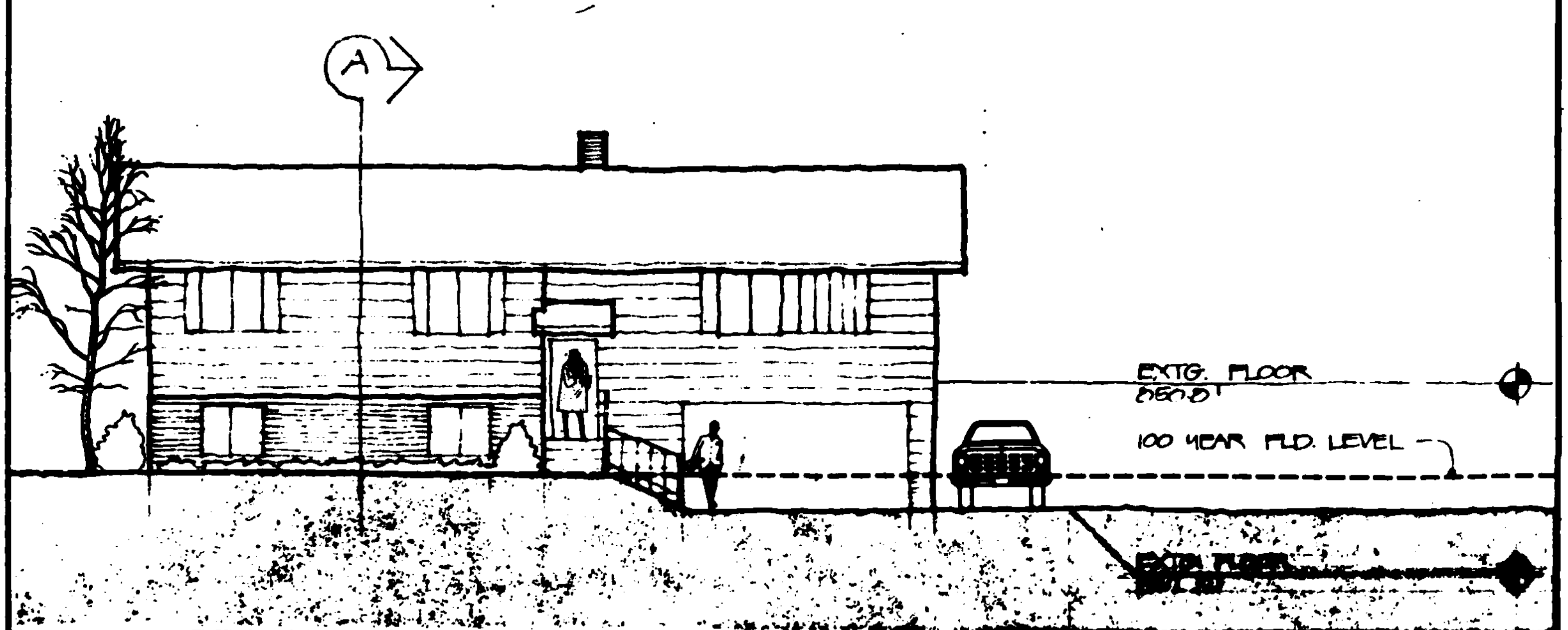
4

PLATE H-13 H-19



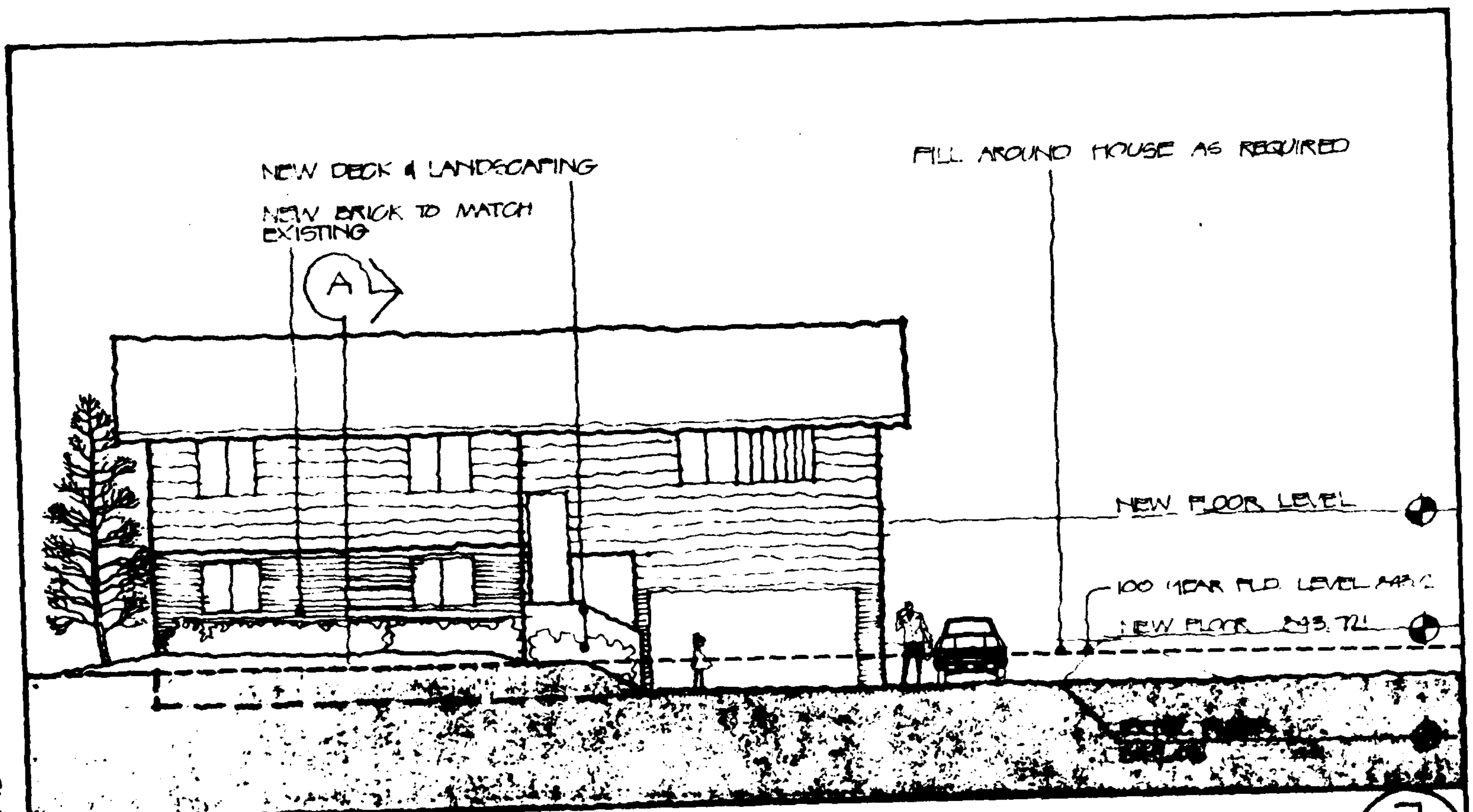
SCHEMATIC SECTION A/A (PROPOSED)
SCALE: 1/8" = 1'-0"
McGOWAN RESIDENCE / 2655 SCOTT AVENUE

5



EXISTING FRONT ELEVATION
SCALE: 1/8" = 1'-0"
McGOWAN RESIDENCE . 2655 SCOTT AVENUE

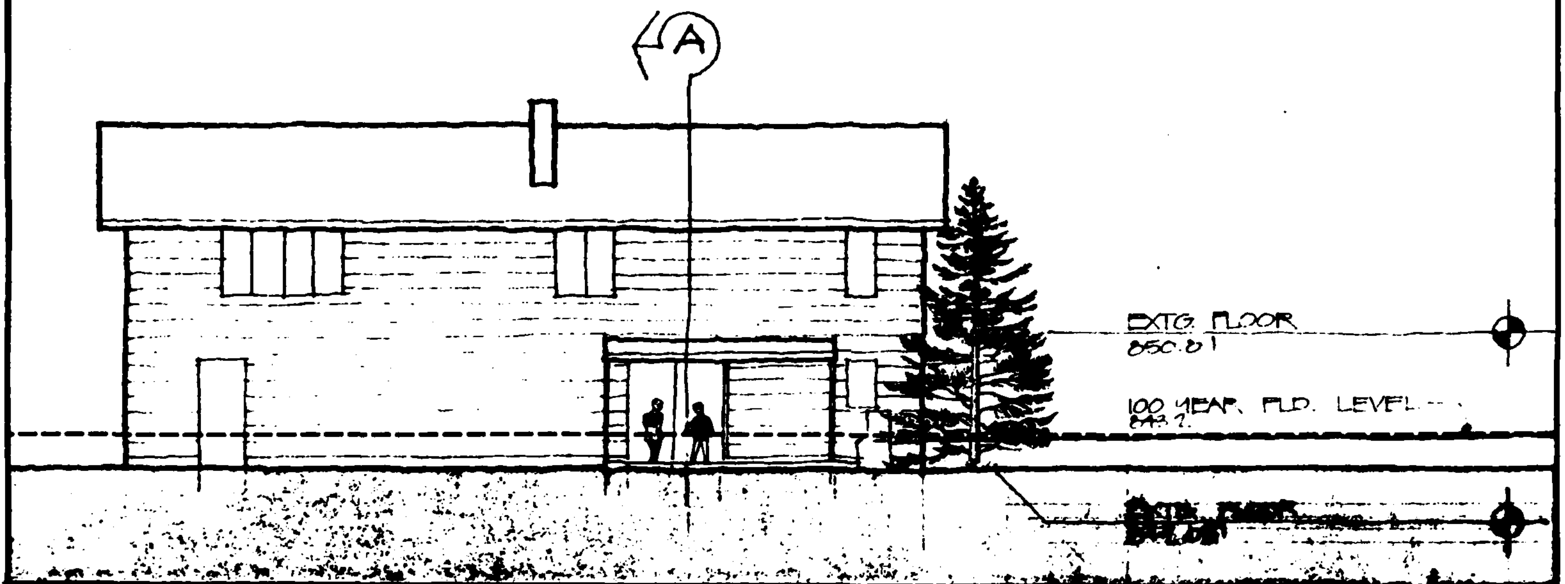
6



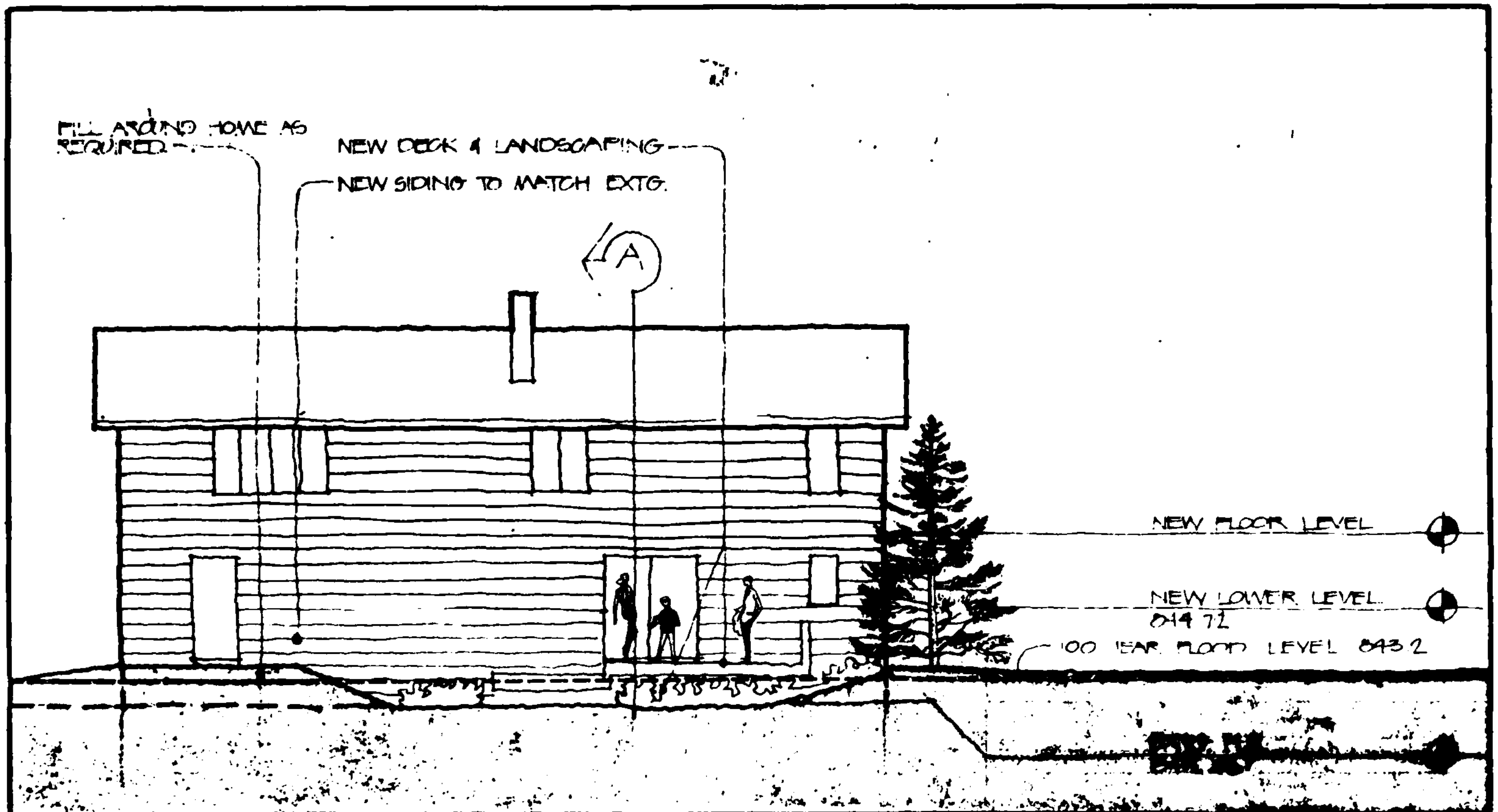
PROPOSED FRONT ELEVATION
SCALE: 1/8" = 1'-0"
McGOWAN RESIDENCE / 2655 SCOTT AVENUE

7

PLATE



EXISTING REAR ELEVATION
SCALE: 1/8" = 1'-0"
McGOWAN RESIDENCE, 2655, SCOTT AVENUE



PROPOSED REAR ELEVATION
SCALE: 1/8" = 1'-0"
McGOWAN RESIDENCE / 2655 SCOTT AVENUE

9

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE GETZKIN RESIDENCE LOCATED AT 2665 SCOTT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA: THE SOIL CONDITIONS AND THE TOPOGRAPHY WILL NOT ALLOW EITHER THE CONSTRUCTION OF A WALL OR BERMING AS A SOLUTION. THE BEARING POTENTIAL IS SUCH THAT PILING WOULD BE REQUIRED TO SUPPORT A WALL. SINCE THE WATER ENTERS THE HOME ON TWO SIDES THERE IS NO TOPOGRAPHY TO USE IN AN EFFORT TO BLEND A BERM INTO THE SURROUNDING LANDSCAPE.

IT IS RECOMMENDED THAT THE RESIDENCE BE RAISED. THE LEVEL OF THE BASEMENT FLOOR IS 841.15 FT. THE ELEVATION OF THE ONE HUNDRED YEAR FLOOD LEVEL IS 844.09 FT. THE RESIDENT HAS AN ELABORATE BRICK FIREPLACE ON EACH LEVEL WHICH STACK VERTICALLY. THE LOWER LEVEL IS COMPLETELY FINISHED. THE LOWER LEVEL OF THIS HOME INCLUDING THE GARAGE IS 3.25 FT. LOWER THAN THE ONE HUNDRED YEAR FLOOD LEVEL. CONSEQUENTLY, THE MAJORITY OF THE WATER DAMAGE OCCURS FROM THE STREET SIDE. APPROXIMATELY 3 FT. OF WATER STOOD IN THE BASEMENT IN THE 1978 FLOOD. WE RECOMMEND THAT THE ENTIRE HOME BE RAISED TO A LEVEL OF 845.45 FT. WHICH WOULD THEN BE ONE FOOT ABOVE THE ONE HUNDRED YEAR FLOOD LEVEL.

WE RECOMMEND THAT THE GARAGE SHOULD BE INCLUDED WITHIN THE RAISE DUE TO ITS RELATION TO THE STREET ELEVATION. THIS WILL REQUIRE SOME ADDITIONAL STRUCTURAL MEASURES WITHIN THE FLOOR SLAB TO THE SUPPORT THE FLOOR. IT WILL BE NECESSARY TO REINFORCE THE SLAB OR CONSTRUCT CONCRETE BEAMS BETWEEN THE PILINGS TO SUPPORT THE NEW SLAB AND KEEP THE PILINGS FROM PUSHING THROUGH THE FLOOR.

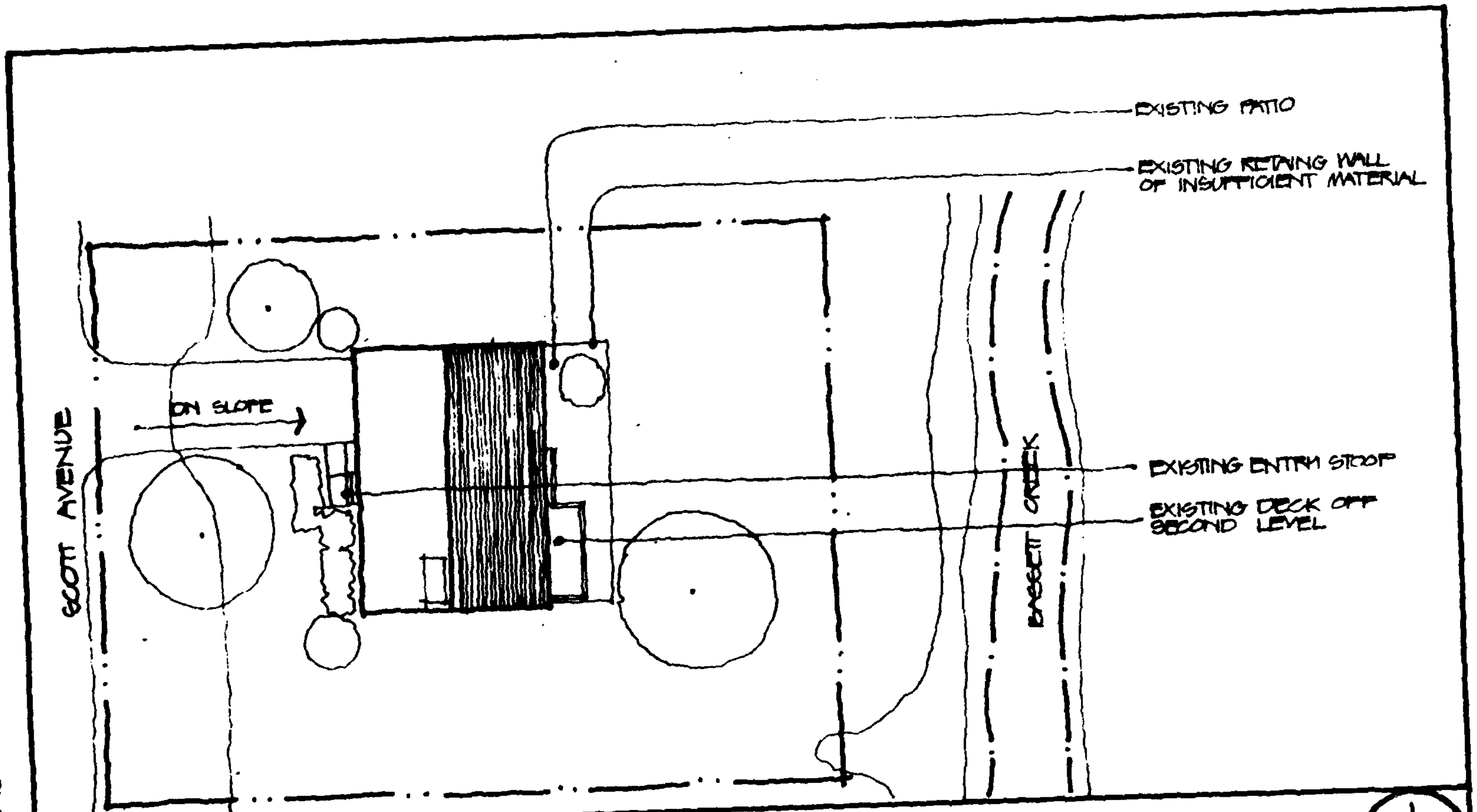
SEE PLATES H-19 THROUGH H-27.

SUMMARY OF ELEVATIONS:

SIDE DOOR	841.15
DOOR @ DECK	849.63
WINDOW SILL	844.68
DOOR SILL	841.21
WALL	842.72

CONSTRUCTION ESTIMATE:
2665 SCOTT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA

CARPENTRY	$22,700.00
MASONRY	
UNDER PIN WALLS	4,000.00
GARAGE GRADE BEAMS @ 8.00 SQ FT	1,300.00
NEW GARAGE FLOOR @ 1.40 SQ FT	1,100.00
ELECTRICAL	700.00
PLUMBING	3,800.00
HVAC	2,700.00
HOME RAISE	10,100.00
PERMITS & PLAN CHECK	300.00
	100.00
TOTAL ESTIMATE:	$46,800.00



EXISTING SITE PLAN
SCALE: 1" = 20'
GETZKIN'S RESIDENCE, 2665 SCOTT AVENUE

PLATE IV-19

4-19

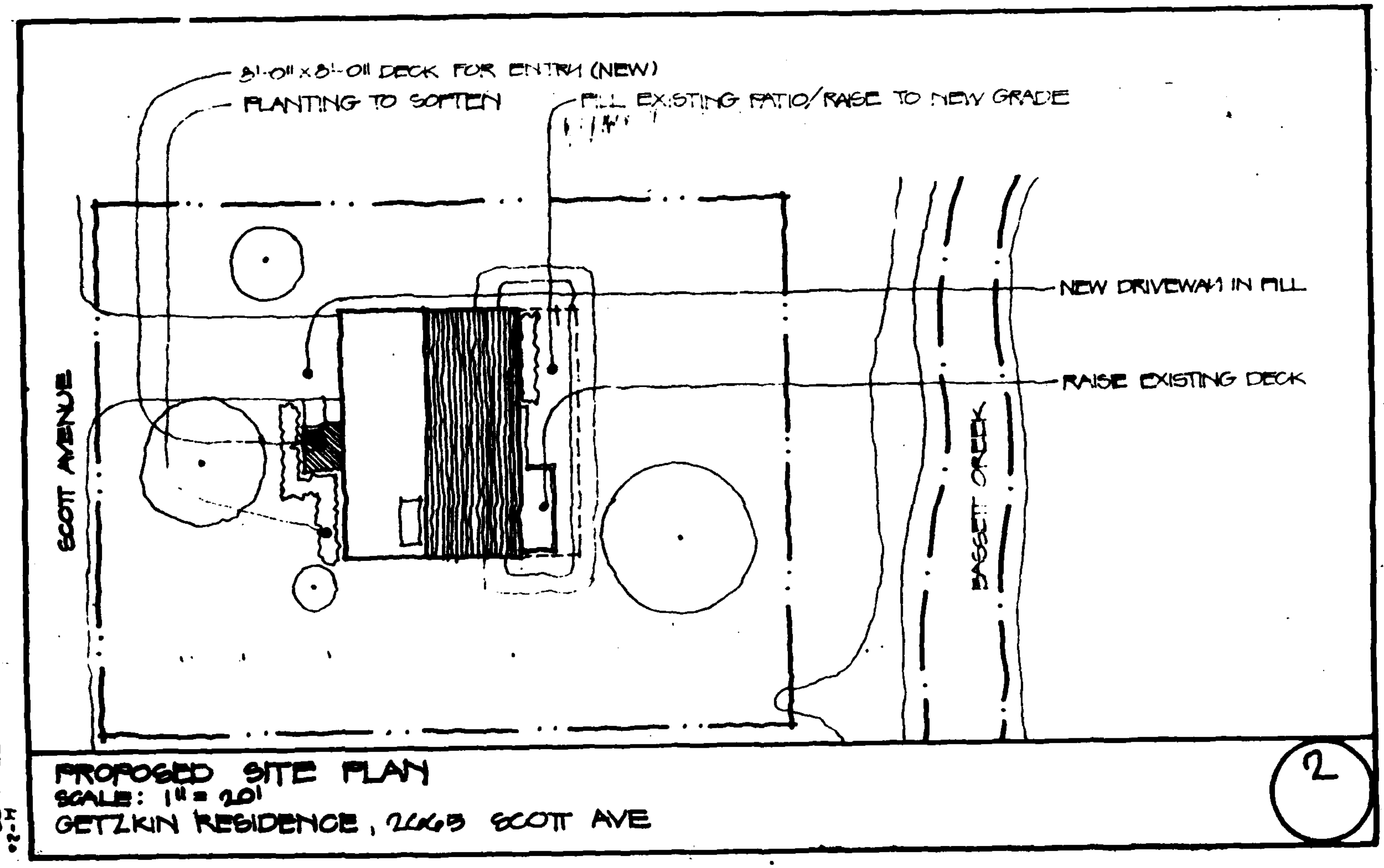
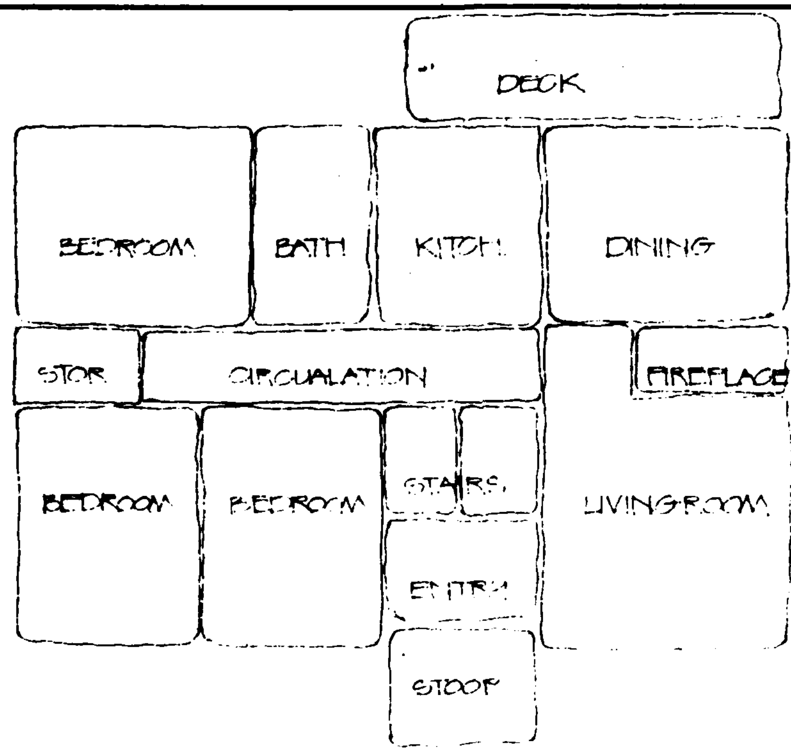
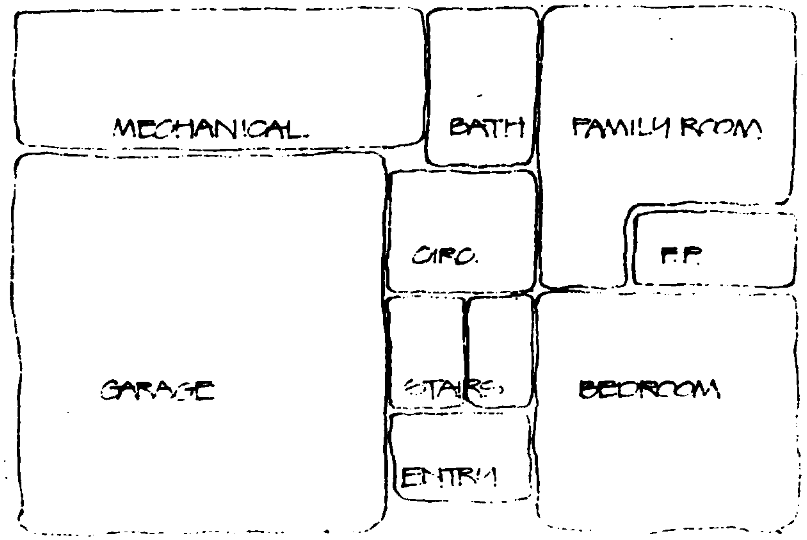

8'-0" x 8'-0" DECK FOR ENTRY (NEW)
PLANTING TO SOFTEN
FILL EXISTING PATIO/RAISE TO NEW GRADE
NEW DRIVEWAY IN FILL
RAISE EXISTING DECK
SCOTT AVENUE
BASSETT CREEK
PROPOSED SITE PLAN
SCALE: 1" = 20'
GETZKIN RESIDENCE, 2665 SCOTT AVE
2

PLATE H-20



SCHEMATIC FLOOR PLAN / UPPER LEVEL
SCALE: 1/8" = 1'-0"
GETZKIN RESIDENCE, 2663 SCOTT AVENUE

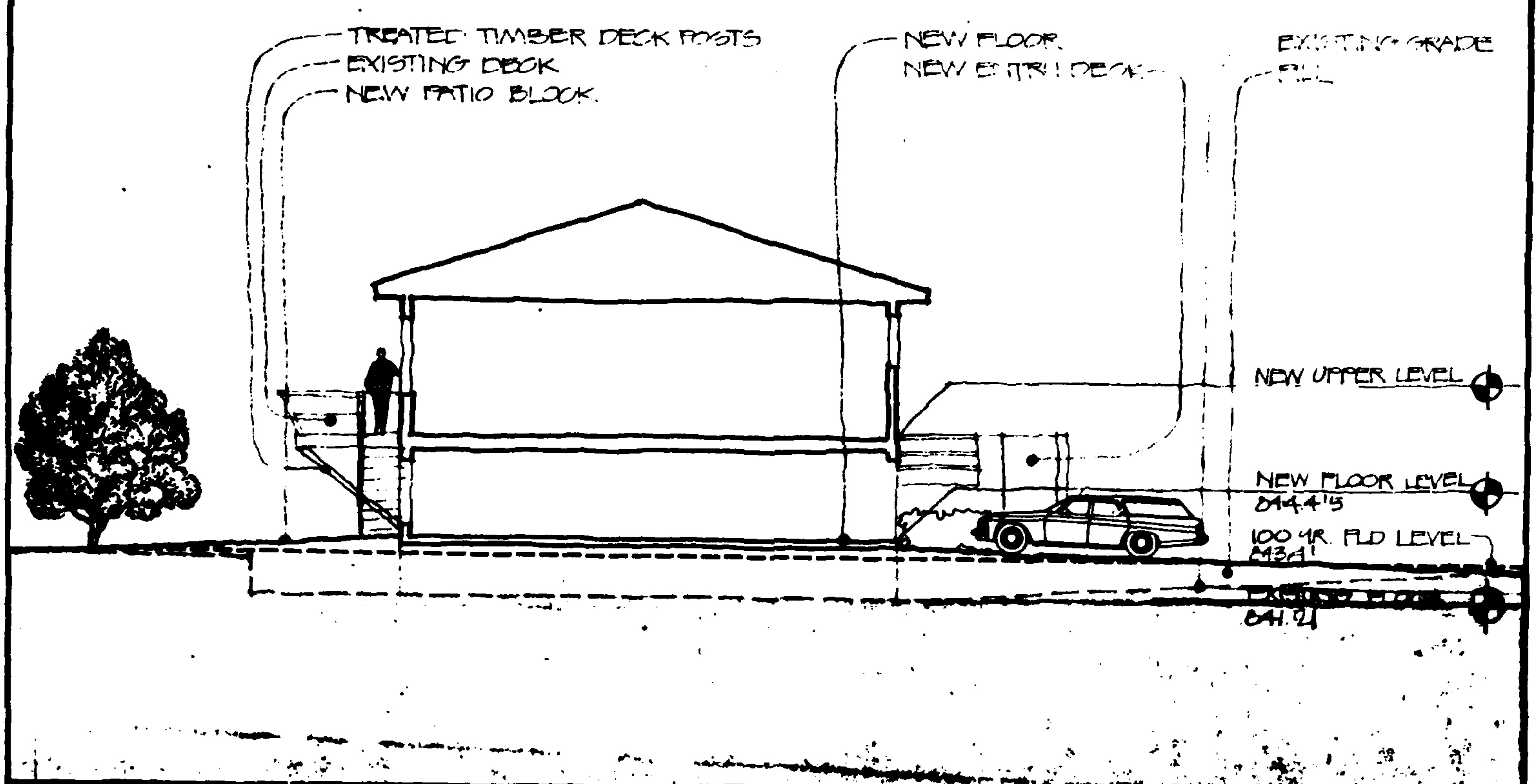
3



SCHEMATIC FLOOR PLAN / LOWER LEVEL
SCALE: 1/8" = 1'-0"
GETZKIN RESIDENCE, 2665 SCOTT AVENUE

4

PLATE H-22 11-22

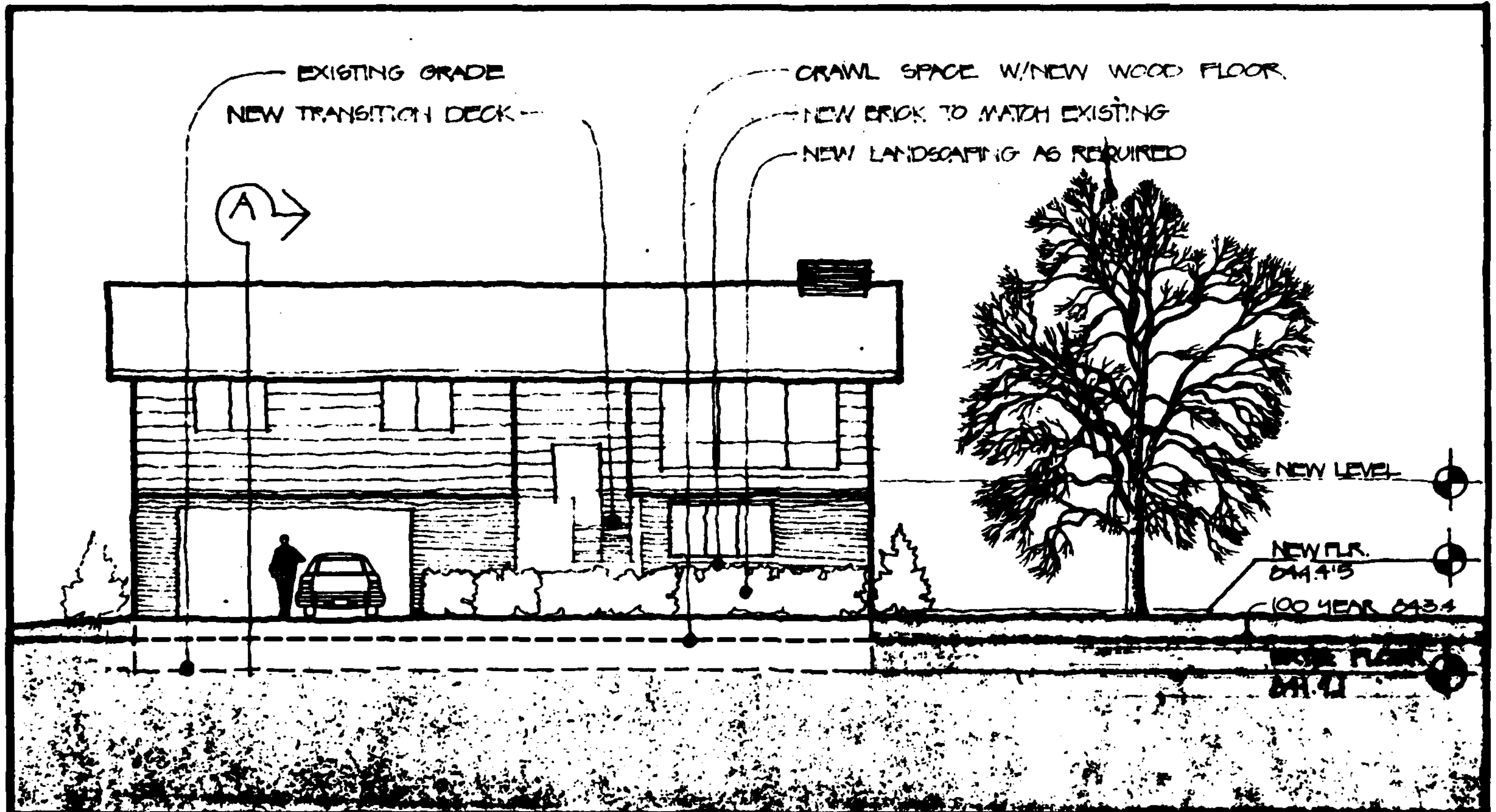


SCHEMATIC SECTION A/A (PROPOSED)
SCALE : 1/8" = 1'-0"
GETZKIN RESIDENCE 2665, SCOTT AVENUE

5

H-23

PLATE H-23

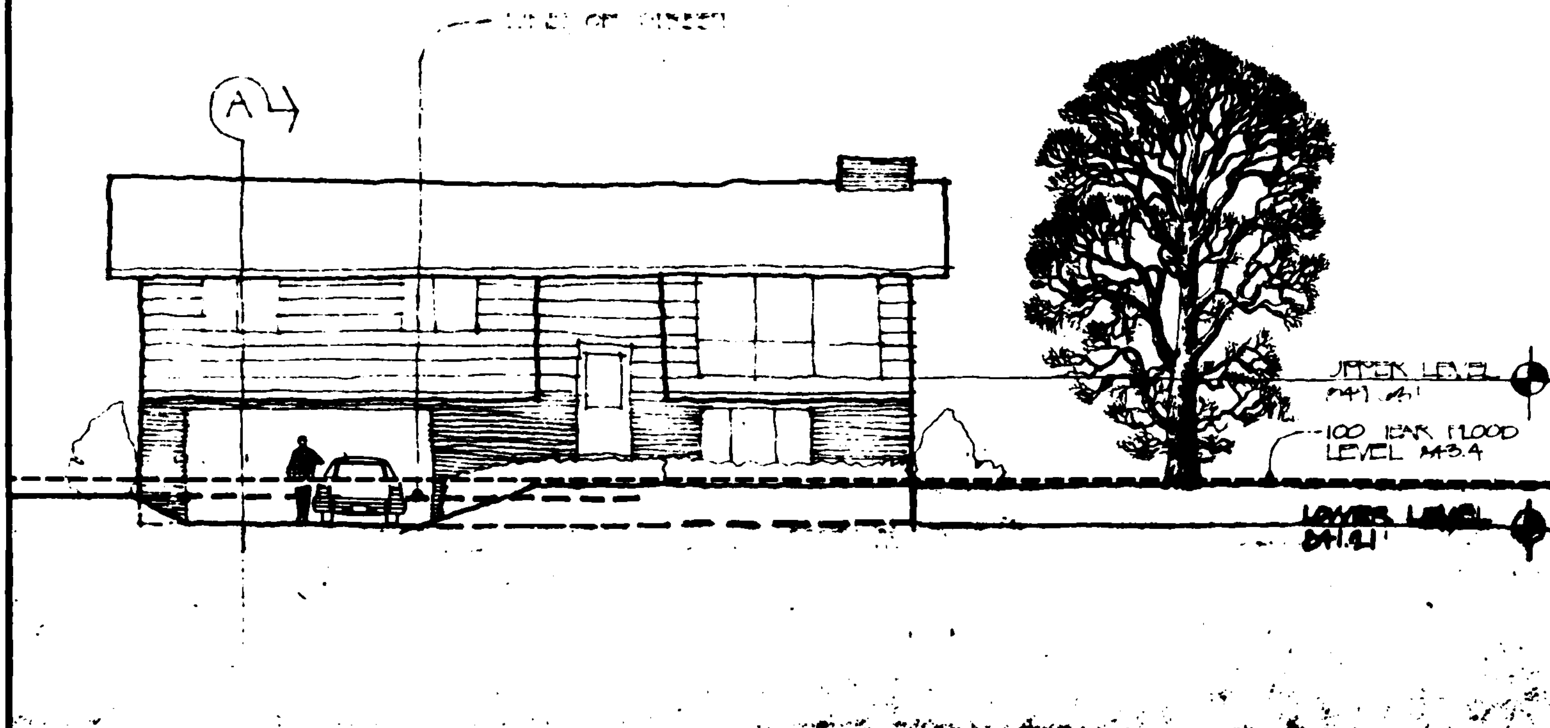


PROPOSED FRONT ELEVATION
SCALE: 1/8" = 1'-0"
GETZKIN RESIDENCE, 2665. SCOTT AVENUE

6

PLATE H-24

4.26

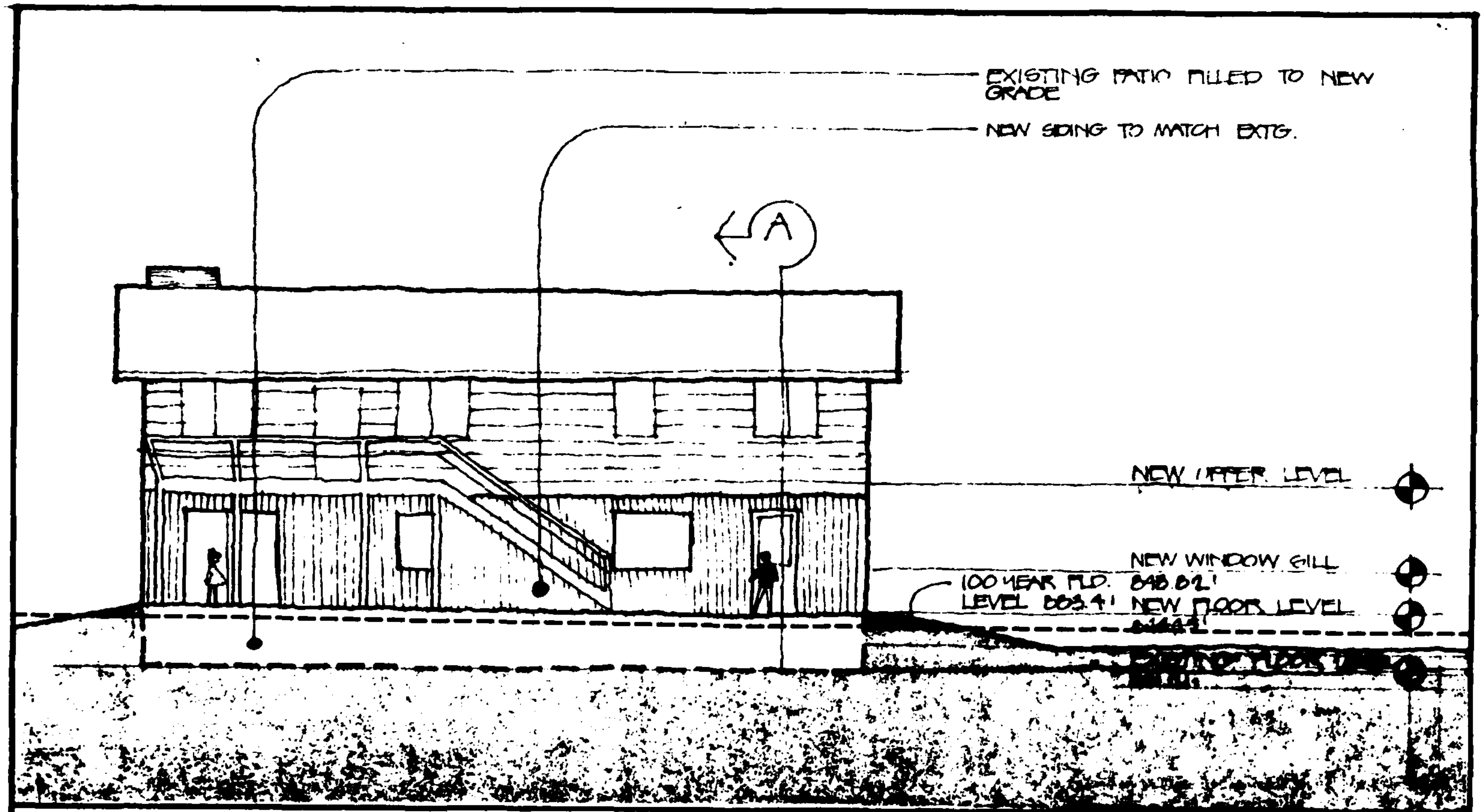


EXISTING FRONT ELEVATION
SCALE: 1/8" = 1'-0"
GETZKIN RESIDENCE 2665, SCOTT AVENUE

7

PLATE H-25

H-25

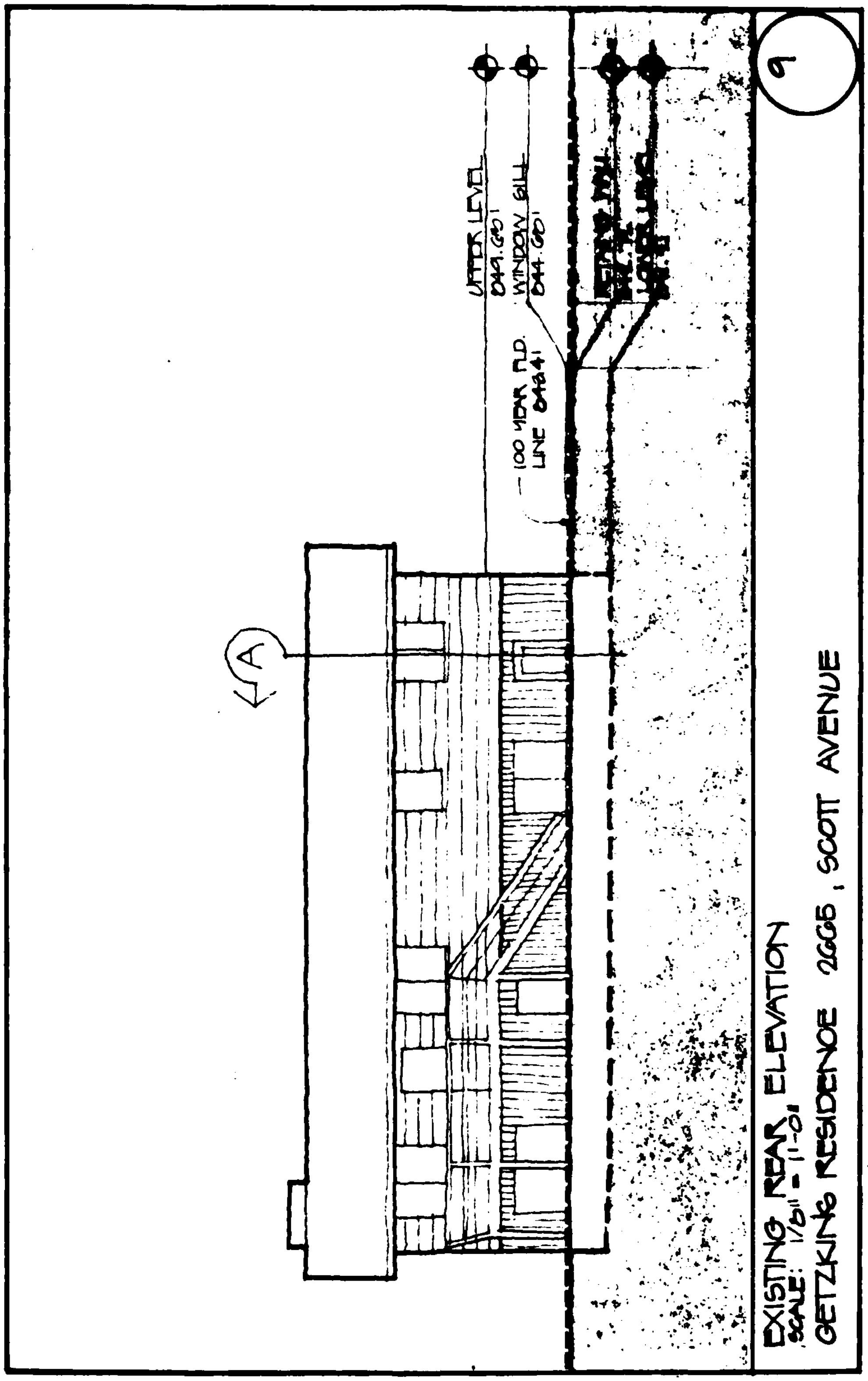


PROPOSED REAR ELEVATION
SCALE: 1/8" = 1'-0"
GETZKINS RESIDENCE 2665, SCOTT AVENUE

B

H-26

PLATE H-26



H-27

PLATE H-27

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE STECKER RESIDENCE LOCATED AT 2675 SCOTT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA: THE SOIL CONDITIONS AND THE SURROUNDING TOPOGRAPHY WILL NOT ALLOW EITHER THE CONSTRUCTION OF A WALL OR A BERM AS A MEANS OF FLOOD-PROOFING THIS STRUCTURE. THE BEARING POTENTIAL OF THE SOIL REQUIRES PILING TO SUPPORT ANY WALLS. THE LACK OF TOPOGRAPHY TO THE SIDES ELIMINATES THE CONSIDERATION OF A BERM.

IT IS RECOMMENDED THAT THIS RESIDENCE BE RAISED AS A MEANS OF FLOOD-PROOFING. THE LEVEL OF THE BASEMENT FLOOR IS 841.09 FT. THE ONE HUNDRED YEAR FLOOD LEVEL IS 843.4 FT. THE LOWER LEVEL OF THE HOME IS COMPLETELY FINISHED. THERE ARE TWO FIREPLACES; ONE ON EACH LEVEL. THE BASEMENT LEVEL OF THE HOME WOULD BE RAISED TO A LEVEL OF 844.39 FT., EXCLUSIVE OF THE ATTACHED GARAGE. THIS WILL PRECLUDE ANY STRUCTURAL MODIFICATIONS TO THE FLOOR SLAB.

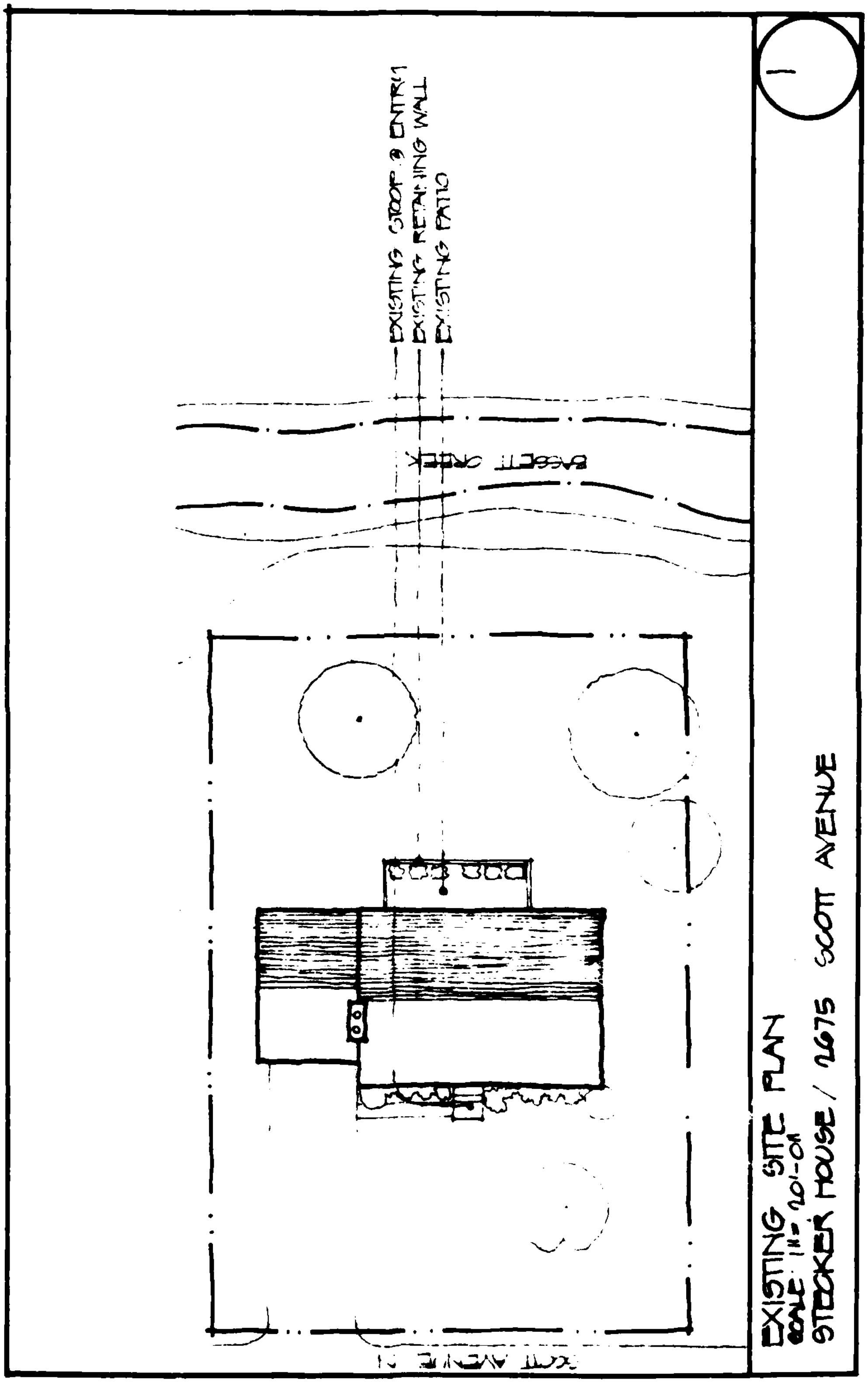
SEE PLATES H-28 THROUGH H-36.

SUMMARY OF ELEVATIONS:

DOOR SILL	841.09
SIDE DOOR	841.15
RETAINING WALL	842.99
FRONT STEPS	842.82
GARAGE DOOR	843.56
FIRST FLOOR	849.59 (APPROX.)

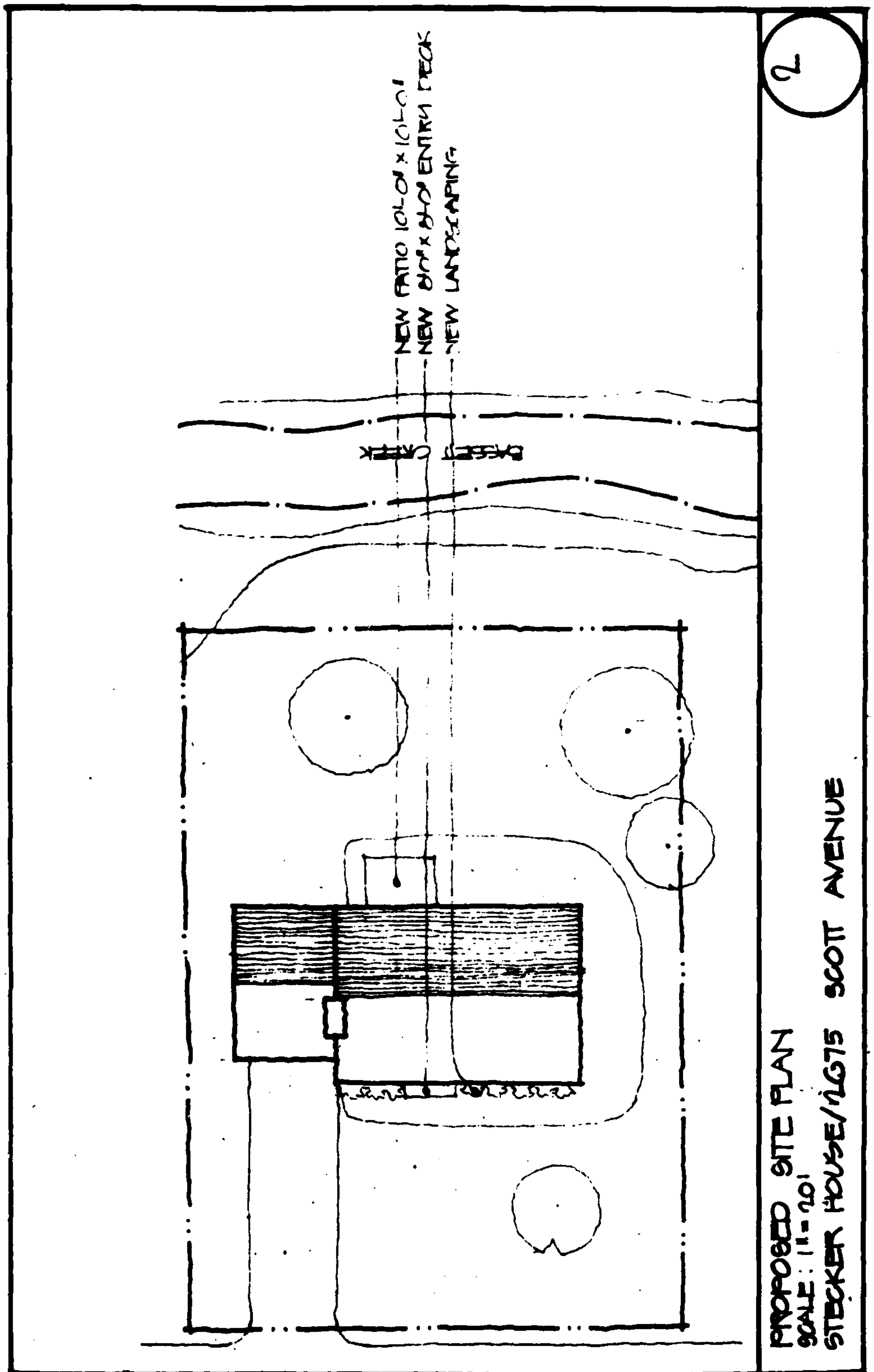
CONSTRUCTION ESTIMATE:
2675 SCOTT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA

CARPENTRY	$22,700.00
MASONRY	
BLOCK	4,000.00
ELECTRICAL	500.00
PLUMBING	3,800.00
HVAC	2,700.00
HOME RAISE	10,100.00
PERMITS & PLAN CHECK	300.00
	100.00
TOTAL ESTIMATE	$44,200.00



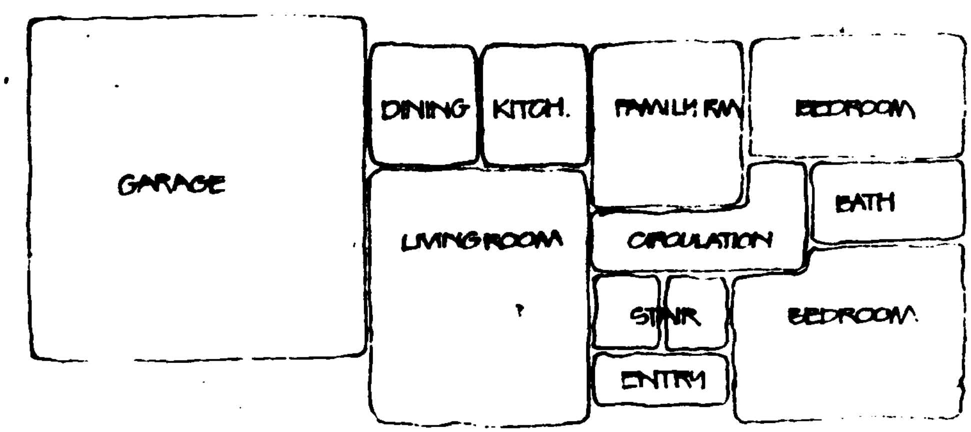
H-28

PLATE H-28



H-29

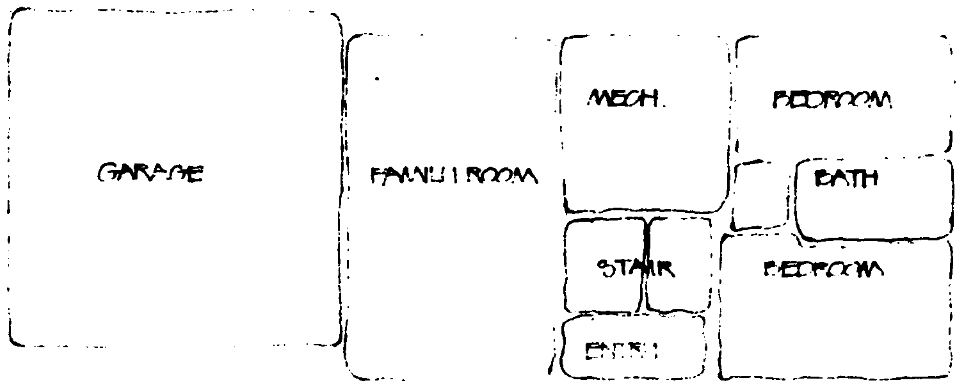
PLATE H-29



SCHEMATIC FLOOR PLAN / UPPER LEVEL
SCALE: 1/8" = 1'-0"
STECKER HOUSE , 2675 SCOTT AVENUE

H-30

PLATE H-30

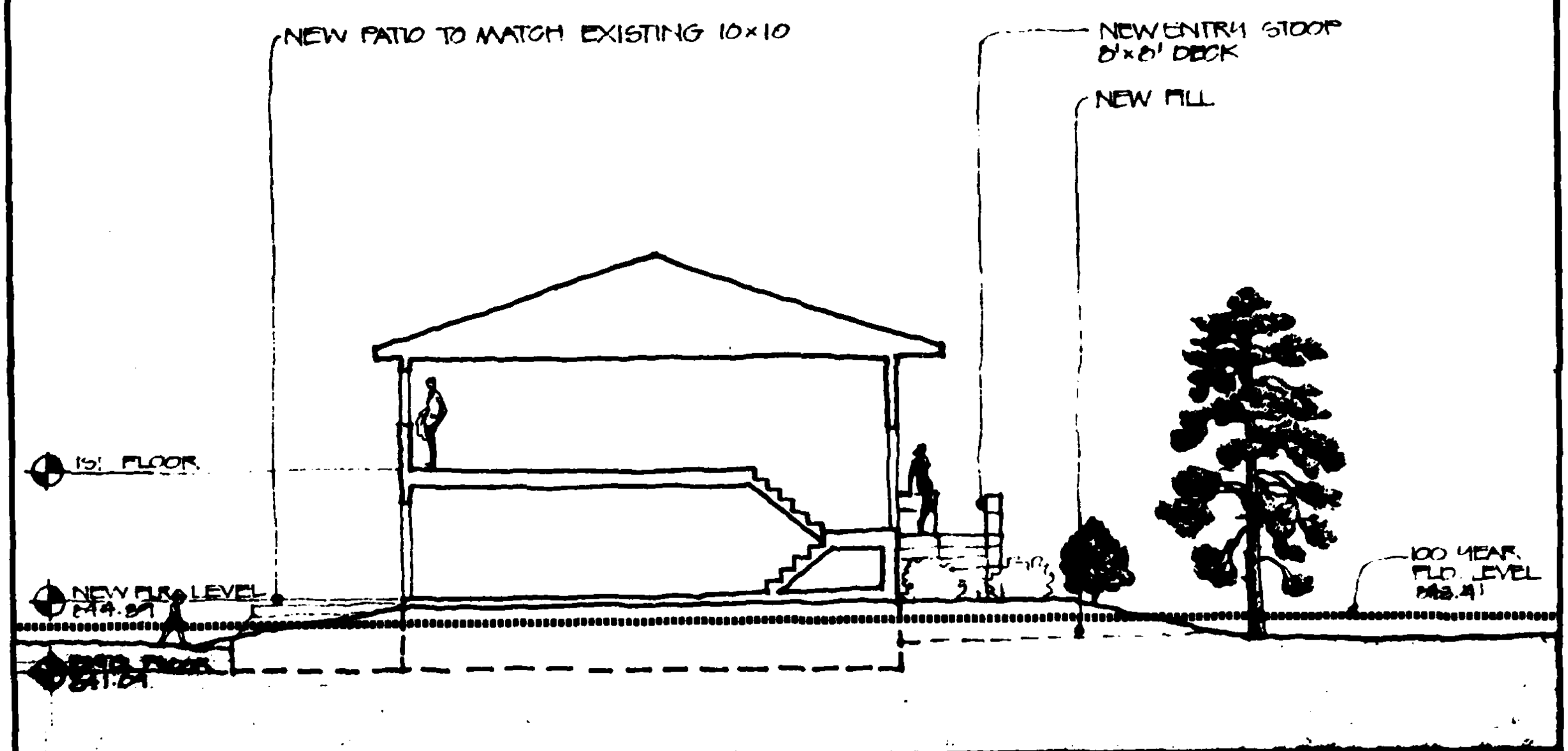


SCHEMATIC FLOOR PLAN / LOWER LEVEL
SCALE 1/8" = 1'-0"
STECKER HOUSE / 2675 SCOTT AVENUE

4

PLATE H-31

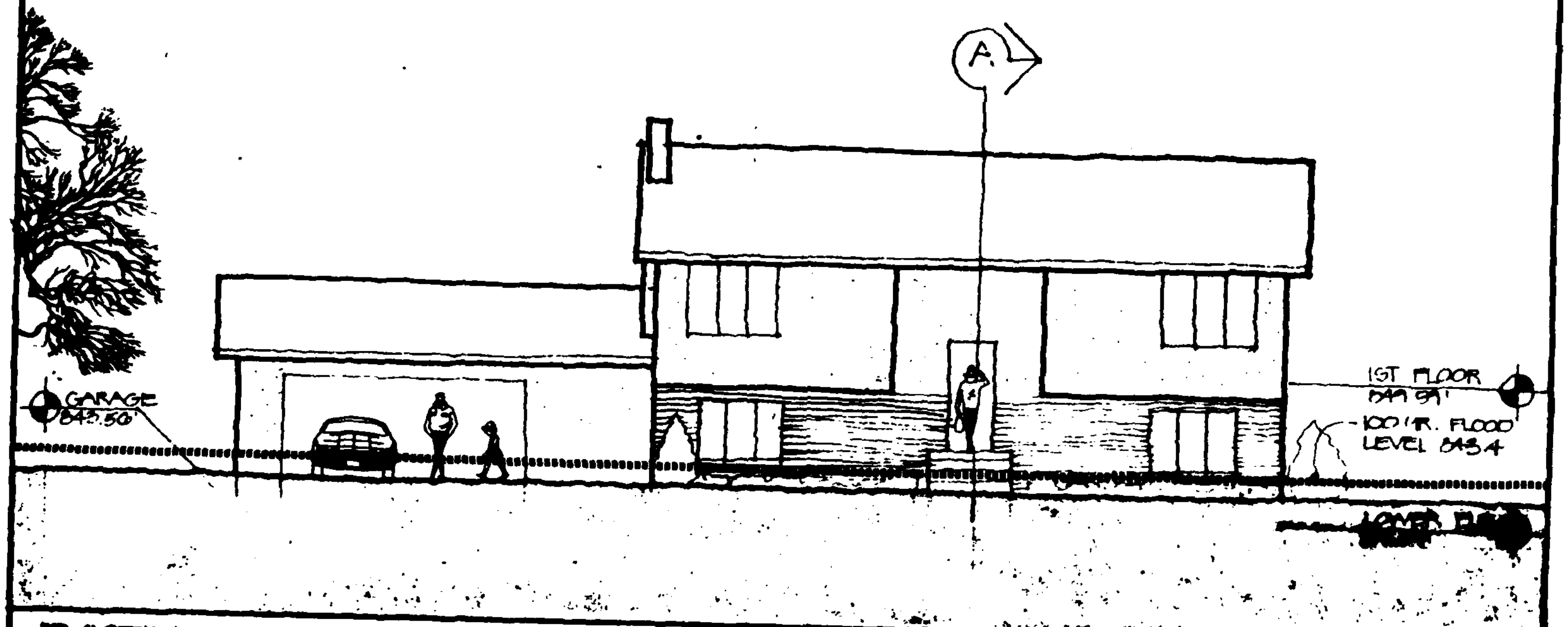
II-31



SCHEMATIC SECTION A/A (PROPOSED)
SCALE: 1/8" = 1'-0"
STECKER HOUSE/ 2078 SCOTT AVENUE

5

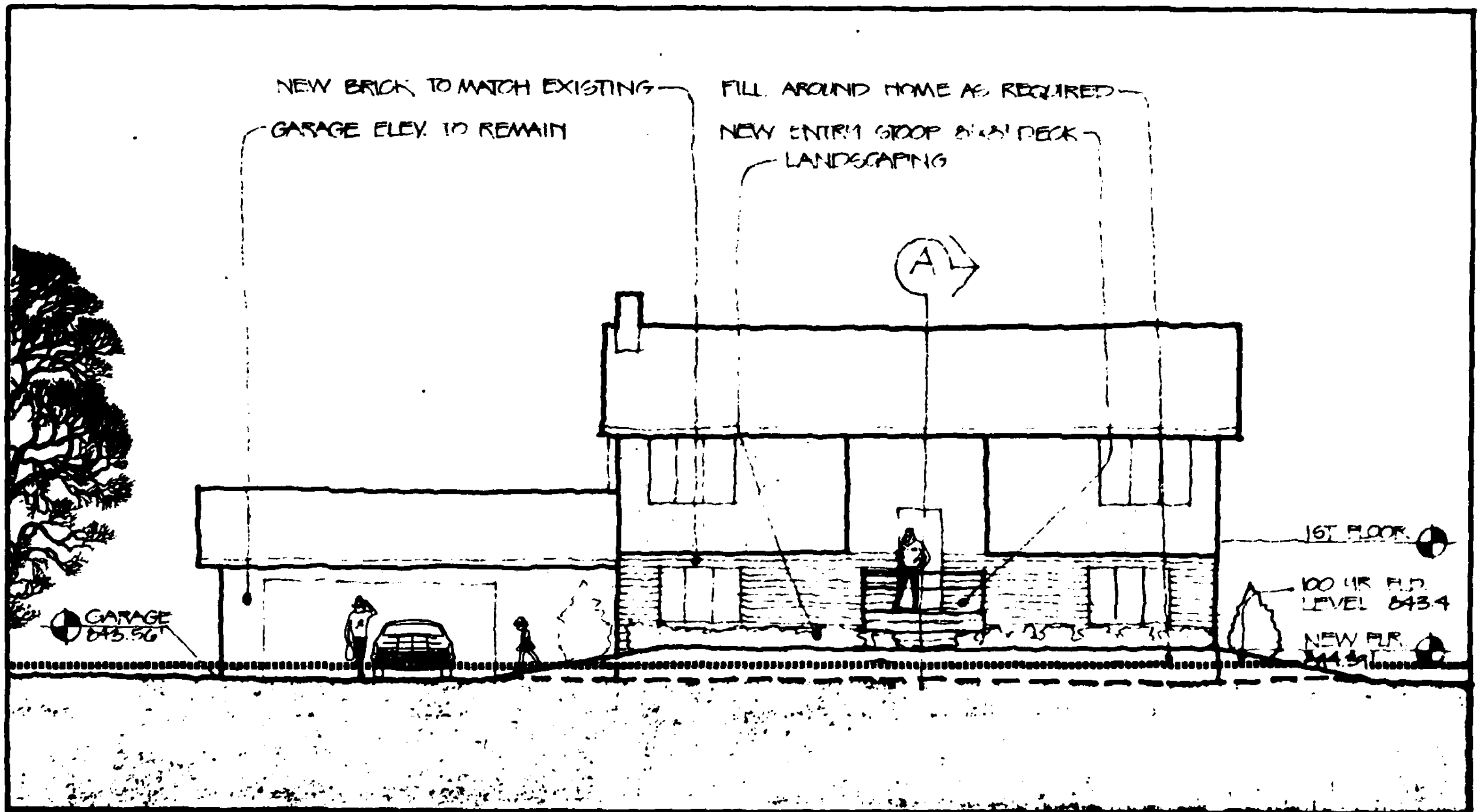
PLATE H-32



EXISTING FRONT ELEVATION
SCALE: 1/8" = 1'-0"
STECKER HOUSE/ 2675 SCOTT AVENUE

G

PLATE H-33

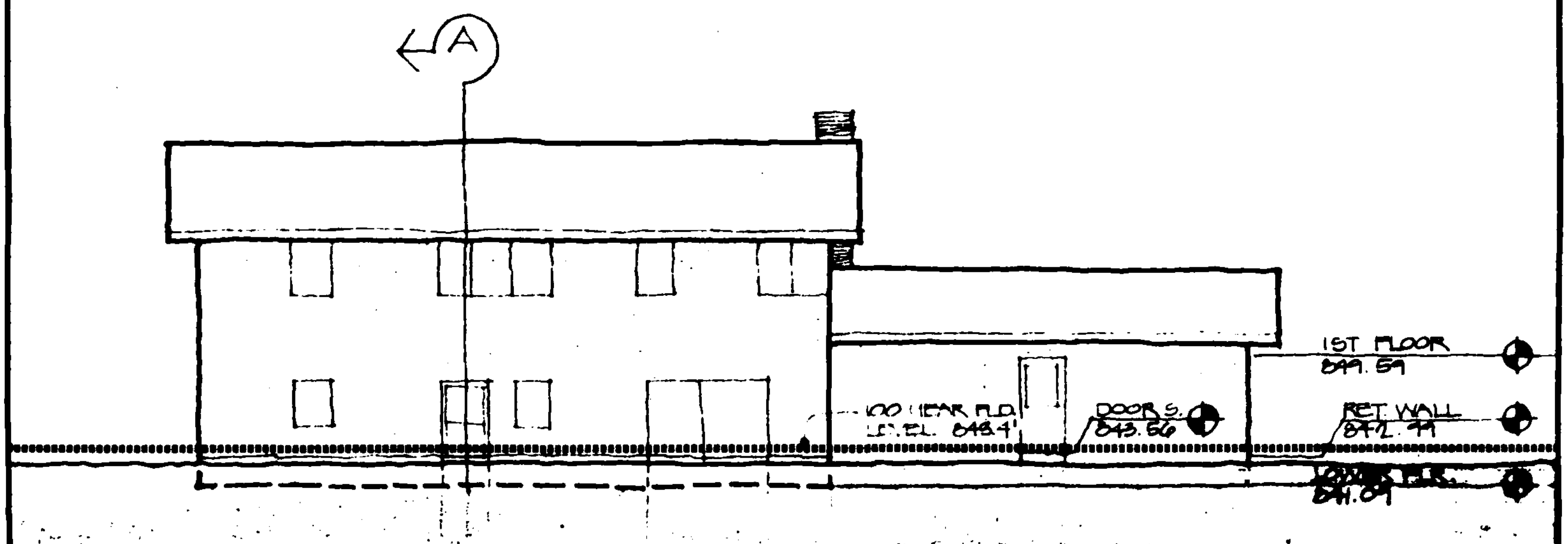


PROPOSED FRONT ELEVATION
SCALE: 1/8" = 1'-0"
STECKER HOUSE / 2675 SCOTT AVENUE

7

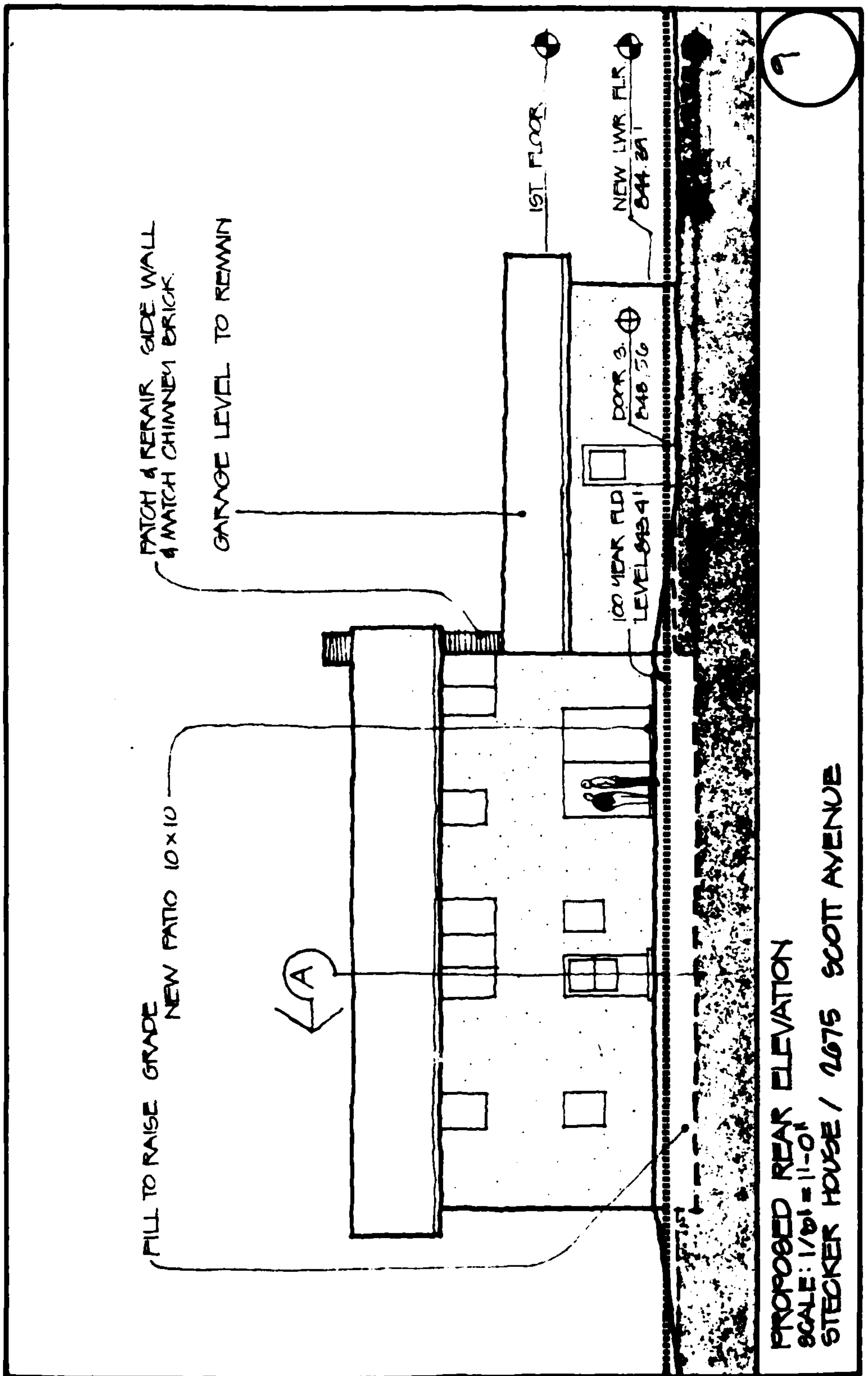
H-34

PLATE H-34



EXISTING REAR ELEVATION
SCALE: 1/8" = 1'-0"
STECKER HOUSE / 2675 SCOTT AVENUE

PLATE H-35



H-36

PLATE H-36

ANALYSIS OF THE PROBLEM - SECOND GROUP

16. A series of three additional design submittals were prepared by Golden Valley which discussed the remaining 20 homes, all located in the city of Golden Valley in an area east of T.H. 100 and north of Golden Valley Road. The addresses are:

2685 Scott Avenue North	3810 Bassett Creek Drive
2725 Scott Avenue North	3820 Bassett Creek Drive
2735 Scott Avenue North	4975 Bassett Creek Drive
2755 Scott Avenue North	5005 Bassett Creek Drive
2775 Regent Avenue North	5110 Minnaqua Drive
1205 Idaho Avenue North	5120 Minnaqua Drive
2425 Regent Avenue North	5126 Minnaqua Drive
2445 Regent Avenue North	5125 Minnaqua Drive
2505 Regent Avenue North	5222 Minnaqua Drive
2545 Regent Avenue North	5130 Minnaqua Avenue North

17. These homes are all located along Bassett Creek. Most have been subject to flood damage in the past. The most recent occurance was in July 1978 when up to 2.5 feet of flood water entered the lower level of these homes.

SOIL CONDITIONS - SECOND GROUP

18. To facilitate technical review of the alternatives considered for each home, a series of hand auger soil borings were generally obtained in the vicinity of each home. These hand soil borings obtained a maximum depth of approximately 10 feet.

19. At the 2685, 2725, 2735 and 2755 Scott Avenue North and the 2775 Regent Avenue North sites, no hand auger borings were made. However, hand auger borings made for homes at 2655 through 2675 Scott Avenue North tend to substantiate the soil borings taken prior to construction of the homes. All five homes have pile foundations. Soil boring logs and reports and the pile driving logs and reports were obtained from the Building Inspector's records.

20. At the 1205 Idaho Avenue North site, no hand auger borings were made, however, the current owner had the home built for himself and reports that the home's foundation is on a granular material. Based on the observations and the lack of settlement problems in the existing home, we do not anticipate adverse soil conditions at this site.

21. At the 2425 and 2445 Regent Avenue sites, three hand auger borings were obtained on the 2445 lot. The first hole, which was located about 20 feet west of the rear center of the house, indicated a fine brown sand with some gravel to a depth of about 2 1/2 feet, a medium brown sand between the depth of 2 1/2 and

3 1/2 feet, a olive organic soil with some clay between the depths of 3 1/2 and 6 feet and a very wet coarse grey sand and gravel to a depth of 4 1/2 feet where the hole was ended because the sand was sloughing into the hole. The second hole was located about 185 feet west of the rear center of the house, indicated black peat to a depth of 3 feet, a brown coarse sand between the depth of 3 and 4.2 feet and olive color muck containing organic debris and snail shells to a depth of 10 feet where the hole was ended. Water was encountered at a depth of about 4 feet. The third hole was located within 5 feet of the rear of the house indicated 1/2 foot of topsoil over fine sand to a depth of 2.3 feet, a coarse sand between the depths of 2.3 and 4.5 feet and a wet sand with gravel to a depth of 5.5 feet where the hole was ended. Water was encountered at a depth of about 4 1/2 feet.

22. At the 2050 and 2545 Regent Avenue North site, two hand auger borings were made. Both borings indicated a thin layer of topsoil, a layer of black peat followed by a layer of olive color muck containing organic debris and snail shells. The olive color muck is very similar to that found along Scott Avenue and west of T.H. 100 at the T.H. 100 embankment.

23. At the 3810 and 3820 Bassett Creek Drive site, two hand auger borings were obtained. Both holes indicated about 2 feet of clayey sand fill followed by more than 6 feet of soft wet clay. Both holes were ended at a depth of about 8.5 feet. These hand auger borings tend to substantiate the soil borilgs taken prior to construction of the homes. Both homes have pile foundations. The soil boring logs and reports, and the pile driving logs and reports as obtained from the Building Inspector's records were compiled.

24. At the 4975 and 5005 Bassett Creek Drive sites, two hand auger borings were obtained. The first hole, at 4975, indicated about 1 foot of sandy fill over about 2 1/2 feet of topsoil, followed by medium sand at depths of 3.5 to 4.5 feet, then sandy silt from 4.5 to 5.3 feet, coarse sand from 5.3 to 7.0 feet and silt from 7 to 10 feet. The water level was about 6 feet deep. The second hole, at 5005, indicated topsoil to a depth of 3.5 feet, followed by clean, medium to fine sand to a depth of 6.5 feet. The water level was at about 5.0 feet. The boring was ended at a depth of 6.5 feet because the saturated sand sloughed into the bottom of the hole.

25. At the 5110, 5120 and 5126 Minnaqua Drive site, a series of four hand auger borings were obtained. Three of the holes indicated about 2 feet of topsoil, followed by layers of organic silts and clays and at a depth of 4 to 4.5 feet coarse sand was encountered. These holes were ended at depths of 6.0 to 6.5 feet, because the saturated sand sloughed into the bottom of the holes. Water was encountered at a depth of about 4.5 feet in all three holes. The fourth hole, located in the northwest corner of the 5120 property had about 3.5 feet of black topsoil and peat, followed by about 3.5 feet of muck, followed by fibrous muck to the end of the hole at a depth of 10 feet.

26. At the 5125 Minnaqua Drive site, two hand auger borings were obtained. The first hole located 20 feet from the house indicated about 2.5 feet of topsoil, then 1 foot of soft clay, followed by 6.5 feet of peat, muck and fibrous muck to a depth of 10 feet where the hole was ended. Water was found at a depth of about 6 feet. The second hole, located 80 feet from the house, indicated about 3 feet of topsoil following by a 1-foot layer of sand, then a layer of fibrous muck to a depth of 6 feet. Below the depth of 6 feet, coarse sand was encountered to a depth of 7.5 feet where the hole was ended because the saturated sand

sloughed into the bottom of the hole. Water was encountered at a depth of about 4 feet.

27. At the 5222 Minnaqua Drive site, no hand auger borings were obtained, however, a soil boring dated September 20, 1977, was obtained from the Building Inspector's record and is attached. The profile seems to be very similar to that found along the north end of Regent Avenue and along Scott Avenue.

28. At the 5130 Minnaqua Avenue site, two hand auger borings were obtained. The first hole indicated about 2 1/2 feet of topsoil with some gravel, followed by about 1 foot of coarse sand mixed with clay and at a depth of about 3 1/2 feet water was encountered in a gravelly sand layer. The hole was ended at a depth of 4 1/2 feet because the saturated sand sloughed into the bottom of the hole. The second hole indicated about 2 feet of topsoil followed by about 1 1/2 feet of medium brown sand and about 1 foot of peat. At a depth of about 4 1/2 feet, a coarse sand with some gravel was encountered before the hole was ended at a depth of 6 1/2 feet because the sand was sloughing into the hole. The first hole was located approximately 20 feet west of the existing walkout door, while the second hole was located approximately 25 feet west and north of the rear center of the house.

RECOMMENDATIONS - SECOND GROUP

29. Based on the above discussion and an analysis of the available basic alternatives, it is recommended that the adjoining homes at 2685, 2725 and 2735 Scott Avenue North, be flood-proofed by providing a common timber wall located between the rear of the homes and the creek. For the soils which exist at this site, it is anticipated that the wall section indicated will be structurally adequate. A system of drain tile will be provided to intercept seepage under the wall. A sump and sump pump would be provided to collect and discharge seepage and runoff from interior drainage areas. See page H-12 & Plates H-37 through H-39.

30. For the homes at 2755 Scott Avenue North and 2775 Regent Avenue North, it is recommended that the homes be flood-proofed by providing a common earth berm through the backyards between the homes and the creek. A sump and sump pump would be provided to collect and discharge runoff from interior drainage areas. See page H-13 and Plates H-40 and H-41.

31. For the home at 1205 Idaho Avenue North, it is recommended that the home be floodproofed by modifying the existing walkout. The existing homeowner is opposed to blocking the walkout since it would have a significant adverse effect on the property value. The existing windows would be removed, concrete blocks would be added to raise the window sills to above the flood damage elevation, and new windows would be installed. The existing doorway would be lowered to the same elevation as the basement floor. A reinforced concrete masonry landing and steps up to a new patio deck will be provided. Earthfill will be added to berm against the basement foundation and landing. Drain tile would be installed to reduce seepage pressures on the basement floor. A sump pump would be provided to collect and discharge seepage and runoff from interior drainage areas. See page H-14 and Plates H-42 through H-45.

32. For the homes at 2425 and 2445 Regent Avenue North, it is recommended that the homes be flood-proofed by providing a common earth berm across the backyard between the homes and the creek. A sump and sump pump would be provided to

collect and discharge runoff from interior drainage areas. See page H-15 and Plates H-46 and H-47.

33. For the homes at 2505 and 2545 Regent Avenue North, it is recommended that the homes be flood-proofed by providing a common earth berm through the backyards between the homes and the creek. A sump and sump pump would be provided to collect and discharge runoff from interior drainage areas. In addition, an existing storm sewer outlet will be extended to assure that the discharge of stormwater is beyond the berm. See page H-16 and Plates H-48 and H-49.

34. It is recommended that the homes at 3810 and 3820 Bassett Creek Drive be flood-proofed by providing a common timber wall located betwen the homes and the creek. For the soils which exist at this site, it is anticipated that the wall section indicated will be structurally adequate. A system of drain tile will be provided to intercept seepage under the wall. A sump and sump pump would be provided to collect and discharge seepage and runoff from interior drainage areas. See pages H-17 and H-18, Plates H-50 through H-53 and Plate H-57.

35. For 4975 Bassett Creek Drive, it is recommended that the home be flood-proofed by providing a reinforced concrete and reinforced masonry wall between the home and the creek. A system of drain tile will be provided to intercept seepage under the wall. A sump and sump pump would be provided to collect and discharge seepage and runoff from interior drainage areas. See page H-19 and Plates H-58 through H-61.

36. For 5005 Bassett Creek Drive, it is recommended that the home be flood-proofed by providing a reinforced concrete and reinforced masonry wall between the home and the creek. A system of drain tile will be provided to intercept seepage under the wall. A sump and sump pump would be provided to collect and discharge seepage and runoff from interior drainage areas. See page H-20 and Plates H-63 through H-65.

37. For the homes at 5110, 5120 and 5126 Minnaqua Drive, it is recommended that the homes be flood-proofed by providing a common earth berm through the backyards between the homes and the creek. A sump and sump pump would be provided to collect and discharge runoff from interior drainage areas. See pages H-21 and H-22 and Plates H-66 and H-67.

38. For homes at 5125 and 5222 Minnaqua Drive, it is recommended that each home be flood-proofed by providing separate earth berm - one across each backyard between the house and creek. A sump and sump pump would be provided to collect and discharge runoff from each interior drainage area. See page H-23 and H-24 and Plates H-68 through H-72.

39. It is recommended that the home at 5130 Minnaqua Avenue North be flood-proofed by providing earthfill against the foundation at the walkout level. The door on the walkout level would be replaced with a window and earthfill would be placed against the foundation to the flood protection elevation. Window wells would to be used to allow earthfill to be placed to an elevation about 0.5 feet above the window sills. Negligible settlement of the earthfill is expected on the sandy soils which exist around the walkout. A system of drain tile with a sump pump would be provided along the west and north sides between the house and the creek to prevent undesirable seepage and uplift pressures on the existing basement floor. See page H-25 and Plates H-73 through H-78.

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE PETERSON RESIDENCE LOCATED AT 2685 SCOTT AVENUE, THE ROBERTS RESIDENCE LOCATED AT 2725 SCOTT AVENUE, AND THE SVIHEL RESIDENCE LOCATED AT 2735 SCOTT AVENUE, GOLDEN VALLEY, MINNESOTA: THE LOW OPENINGS ARE 841.98, 842.62, AND 843.17, RESPECTIVELY. THE 100-YEAR FLOOD LEVEL IS 843.5. WE MUST FLOOD-PROOF TO A LEVEL OF 844.5.

IN CONSIDERATION OF THE PROXIMITY OF THE THREE HOMES, AND THE FACT THAT THE ELEVATIONS ARE APPROXIMATELY THE SAME, THE BEST SOLUTION WOULD BE A TREATED TIMBER RETAINING WALL THROUGH THE REAR YARDS OF THESE THREE HOMES. THIS RETAINING WALL WOULD TIE INTO THE EXISTING CONTOURS OF 2735 AND 2685 SCOTT AVENUES. WE MUST THEN PROVIDE AN INTERIOR DRAINAGE SYSTEM WITH A SUMP PUMP.

SEE PLATES H-37 THROUGH H-39.

SUMMARY OF ELEVATIONS - 2685 SCOTT AVENUE

DOOR SILL	841.98
DOOR SILL	844.89
UPPER DECK	849.59
100-YEAR FLOOD LEVEL	843.5
FLOOD-PROOF LEVEL	844.5

SUMMARY OF ELEVATIONS - 2725 SCOTT AVENUE

DOOR SILL (PATIO DOOR)	842.63
DOOR SILL (PANEL DOOR)	842.62
WINDOW SILL	845.87
100-YEAR FLOOD LEVEL	843.5
FLOOD-PROOF LEVEL	844.5

SUMMARY-OF ELEVATIONS - 2735 SCOTT AVENUE

DOOR SILL (LOWER)	843.17
DOOR SILL (UPPER)	845.85
100-YEAR FLOOD LEVEL	843.5
FLOOD-PROOF LEVEL	844.5

CONSTRUCTION ESTIMATE - 2685, 2725 AND 2735 SCOTT AVENUE

EARTHWORK	
EXCAVATION AND BACKFILL	$ 2,100.00
SOD WITH TOPSOIL	950.00
CARPENTRY	
TIMBER WALL	9,340.00
STEPS	1,360.00
DRAINAGE	
SUMP PUMP WITH SUMP	6,050.00
DRAINTILE WITH FILTER	2,350.00
TOTAL ESTIMATE	$22,150.00
OR	$ 7,383.00/HOME

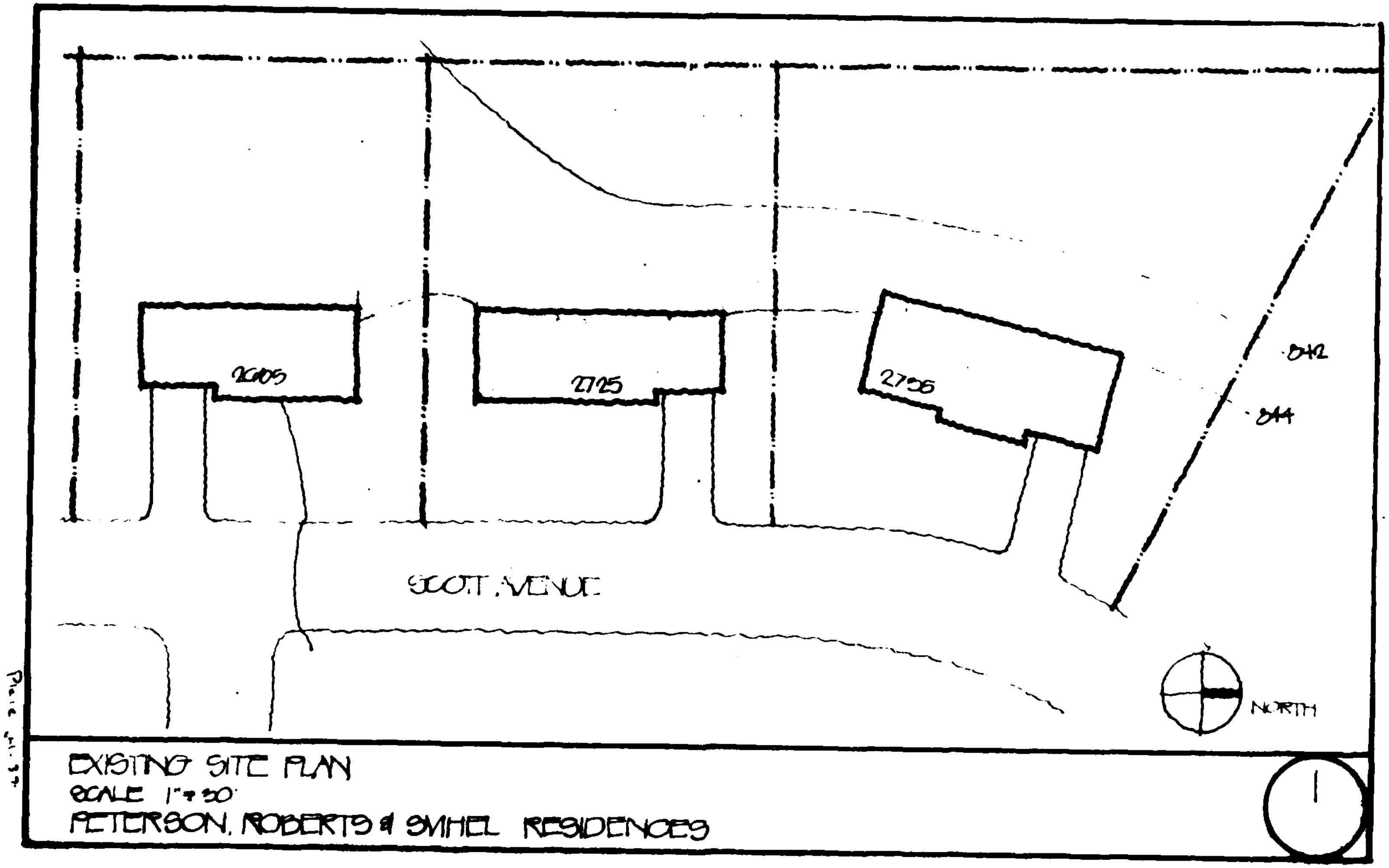
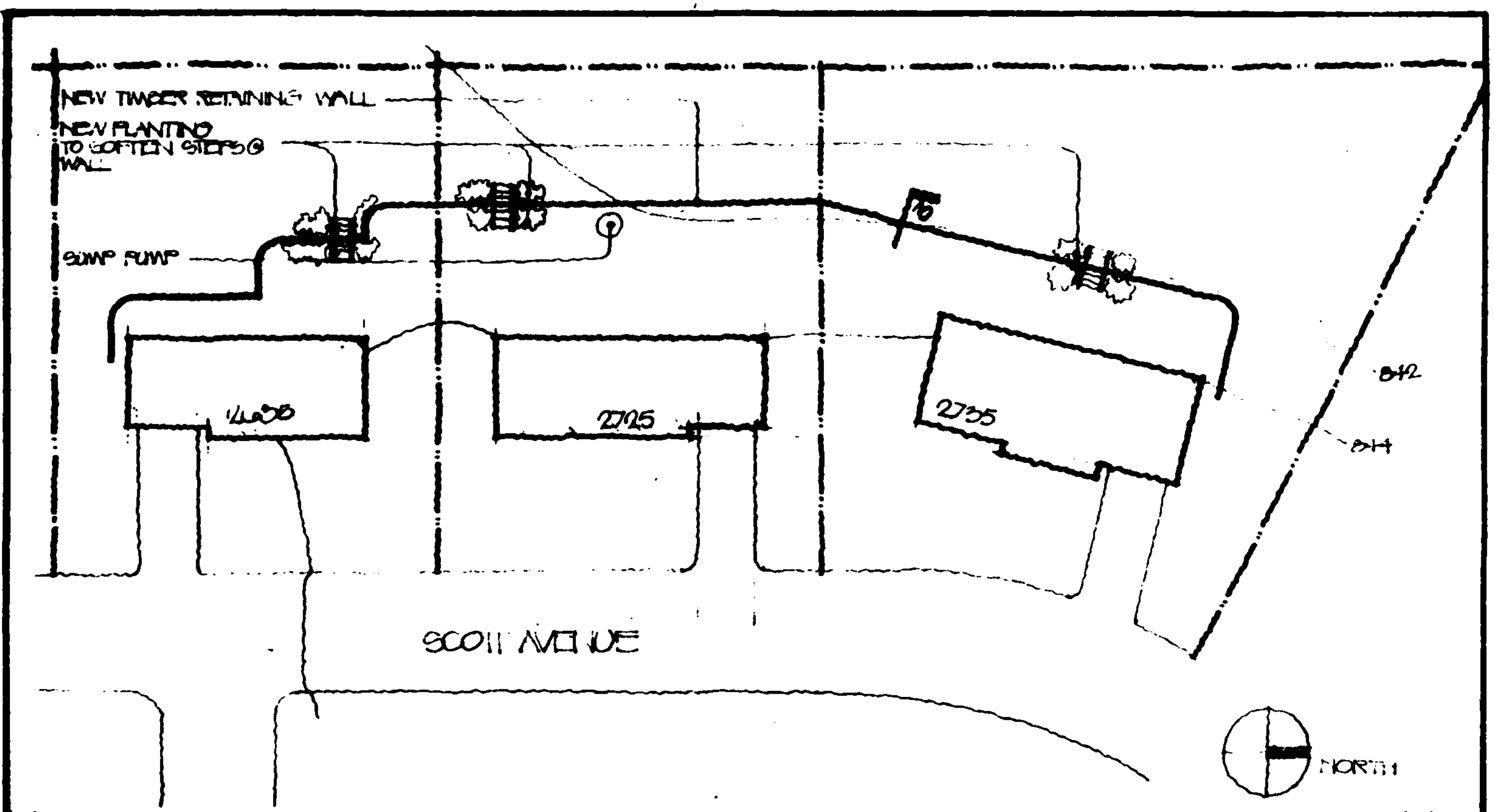


Plate H-37

PLATE H-37



PROPOSED SITE PLAN
SCALE: 1" = 30'
PETERSON, ROBERTS & SVIHEL RESIDENCES

2

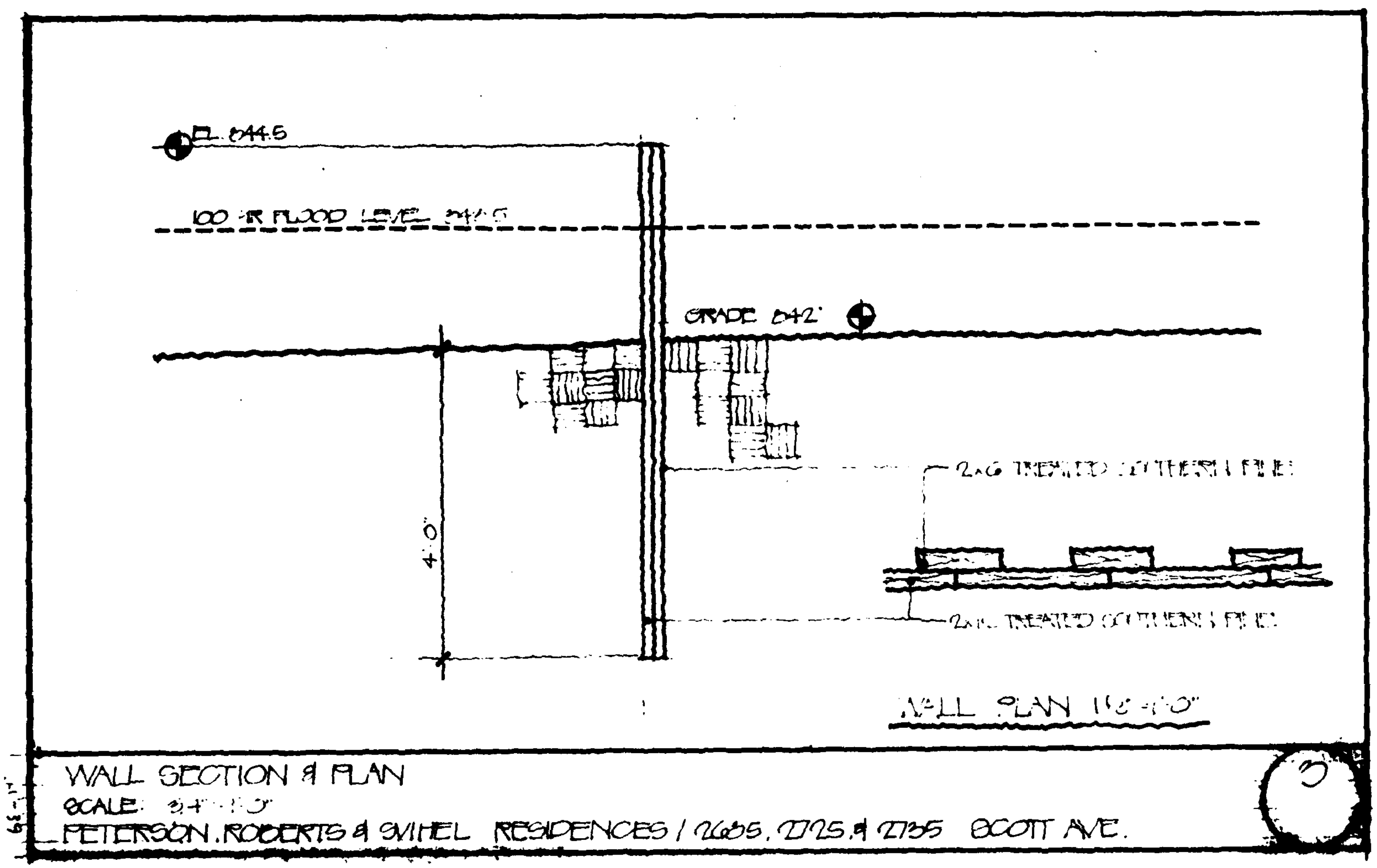

EL. 844.5
GRADE 842'
4'-0"
WALL SECTION & PLAN
SCALE:
PETERSON, ROBERTS & SVIHEL RESIDENCES / 2655, 2725 & 2735 SCOTT AVE.

PLATE H-39

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE SCHMIDT RESIDENCE LOCATED AT 2775 REGENT AVENUE, AND THE ADEMITE RESIDENCE LOCATED AT 2755 SCOTT AVENUE, GOLDEN VALLEY, MINNESOTA: THE LOW OPENINGS FOR THESE TWO RESIDENCES ARE 843.17 AND 843.22, RESPECTIVELY. THE 100-YEAR FLOOD LEVEL IS 843.6. WE MUST FLOOD-PROOF TO A LEVEL OF 844.6.

THE ADEMITE RESIDENCE HAD 3 INCHES OF WATER IN ITS LOWER LEVEL IN 1978. THE SCHMIDT RESIDENCE ALSO EXPERIENCED FLOOD DAMAGE IN 1978.

THE BEST SOLUTION TO THE PROBLEM OF FLOODING IN THIS INSTANCE WOULD BE THE CONSTRUCTION OF A BERM WHICH WOULD TIE INTO THE EXISTING SLOPES OF THE LAND. IT WOULD THEN BE COVERED WITH EARTH AND SODDED OR SEEDED. AN INTERIOR DRAINAGE SYSTEM WITH A SUMP PUMP WOULD ALSO BE CONSTRUCTED.

SEE PLATES H-40 AND H-41.

SUMMARY OF ELEVATIONS - 2775 REGENT AVENUE

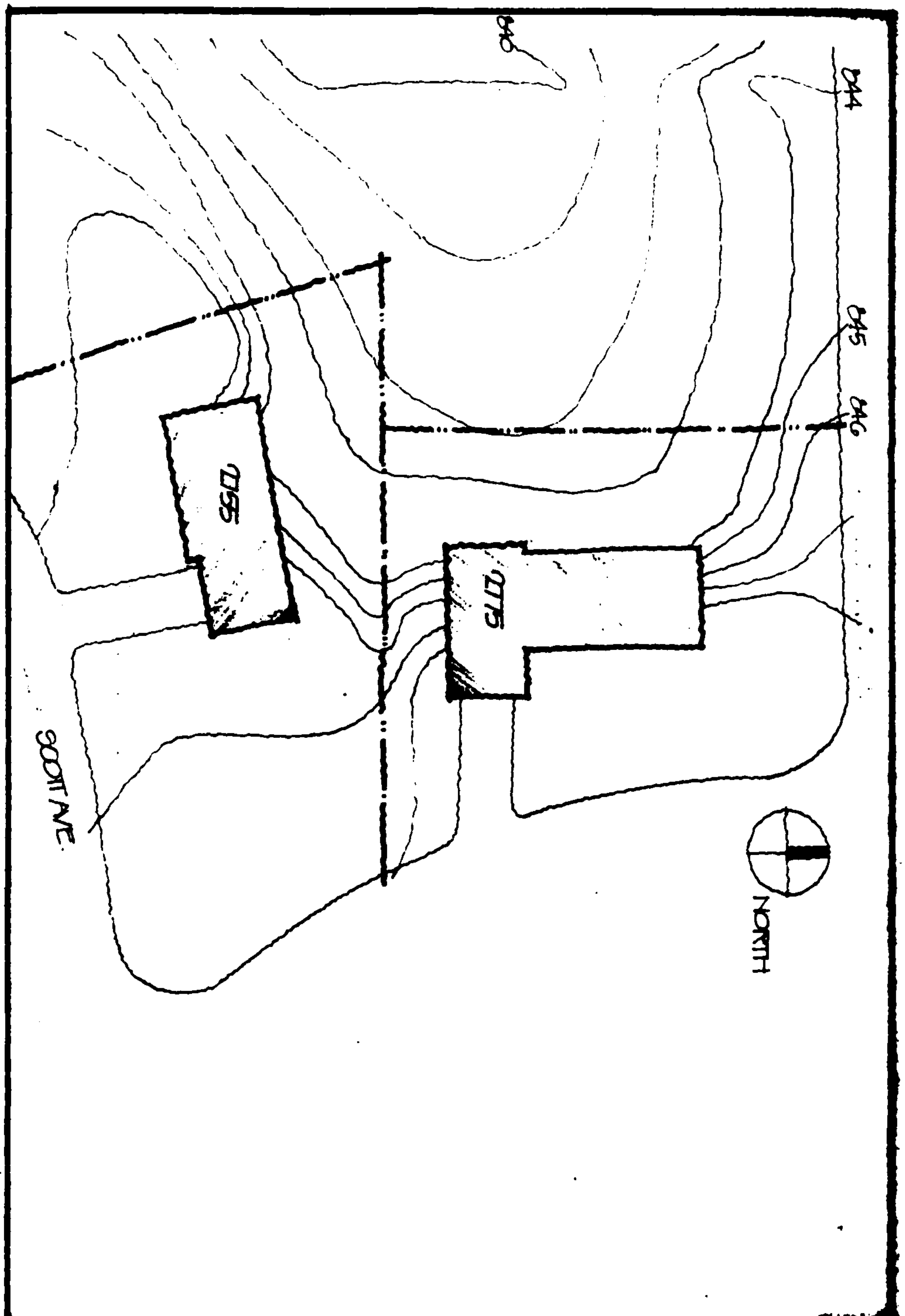
DOOR SILL (PATIO DOOR)	843.19
DOOR SILL (REAR DOOR)	843.17
FIRST FLOOR	851.3

SUMMARY OF ELEVATIONS - 2755 SCOTT AVENUE

DOOR SILL (REAR DOOR)	843.30
DOOR SILL (PATIO DOOR)	843.22
FIRST FLOOR	851.6

CONSTRUCTION ESTIMATE - 2755 REGENT AVENUE AND 2775 SCOTT AVENUE

EARTHWORK	
FILL	$ 2,220.00
SOD OR SEED WITH TOPSOIL	2,830.00
DRAINAGE	
SUMP PUMP WITH SUMP	6,050.00
TOTAL ESTIMATE	$11,100.00
OR	$ 5,550.00/HOME



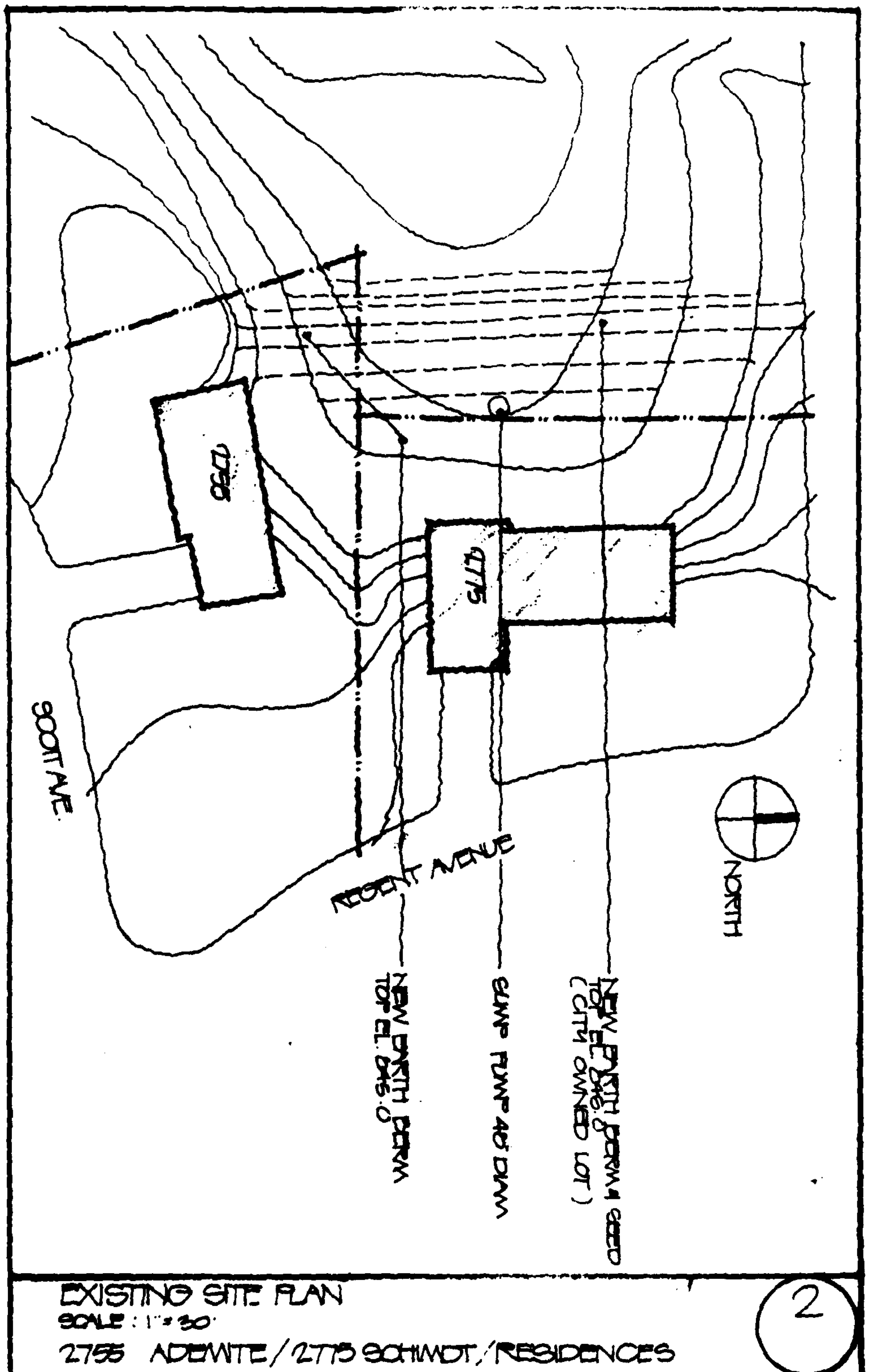
EXISTING SITE PLAN

SCALE: 1"=30'

2755 ADEMITE / 2775 SCHMIDT / RESIDENCES

1

PLATE H-40



EXISTING SITE PLAN
SCALE : 1" = 30'
2755 ADEWITE / 2775 SCHMIDT / RESIDENCES

2

PLATE M-[illegible]

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE KNIGHT RESIDENCE LOCATED AT 1205 IDAHO AVENUE, GOLDEN VALLEY, MINNESOTA: THE LOW OPENING IS 871.30. THE ONE HUNDRED YEAR FLOOD LEVEL IS 871.7. WE MUST FLOOD-PROOF TO A LEVEL OF 872.7.

THE BEST SOLUTION TO THE FLOODING PROBLEM OF THIS HOME WOULD BE THE CONSTRUCTION OF A NEW CONCRETE RETAINING WALL AND A SLAB AT THE DOOR. THIS AREA WOULD SERVE AS A LANDING WITH STEPS GOING UP TO A DECK. THE DECK WOULD REPLACE THE EXISTING PATIO, WHICH WILL BE LOST, AS WELL AS BE ABOVE THE ONE HUNDRED YEAR FLOOD LEVEL. WE MUST ALSO PROVIDE AN INTERIOR DRAINAGE SYSTEM WITH A SUMP PUMP.

SEE PLATES H-42 THROUGH H-45.

SUMMARY OF ELEVATION

LOW OPENING (DOOR SILL)	871.38
ONE HUNDRED YEAR FLOOD LEVEL	871.7
FLOOD-PROOFING LEVEL	872.7

CONSTRUCTION ESTIMATE
1205 IDAHO AVENUE NORTH, GOLDEN VALLEY, MINNESOTA

CARPENTRY	
LABOR & MATERIALS	$ 2,300.00
PATIO (LABOR & MATERIALS)	1,350.00
EARTHWORK	
EXCAVATION AND BACKFILL	950.00
SOD WITH TOPSOIL	350.00
CONCRETE AND MASONRY	
REINFORCED CONCRETE	1,350.00
REINFORCED MASONRY	475.00
UNREINFORCED MASONRY	275.00
DRAINAGE	
SUMP PUMP WITH SUMP	4,050.00
DRAIN TILE WITH FILTER	575.00
TOTAL ESTIMATE	$11,675.00

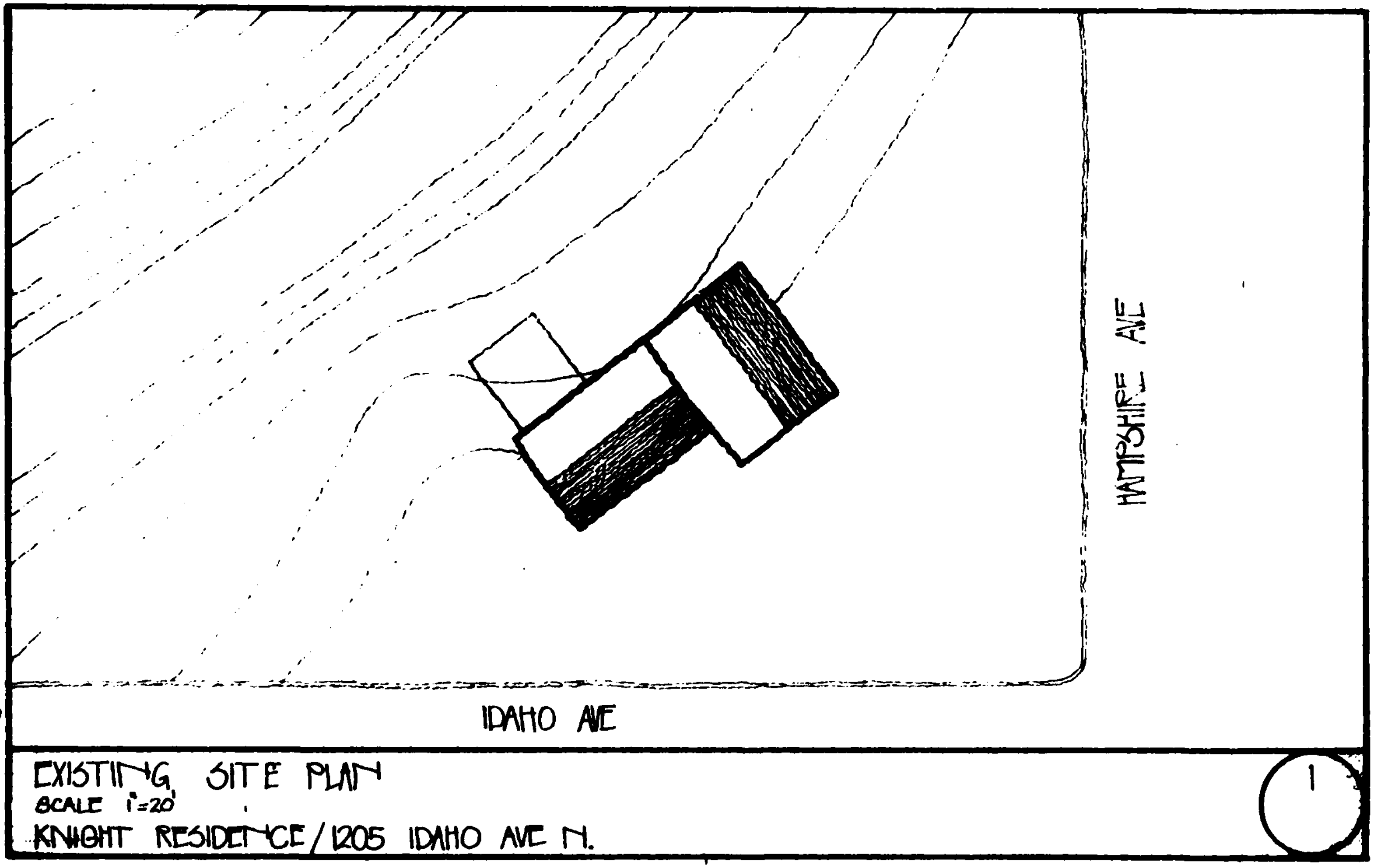


Plate H-42
PLATE H-42

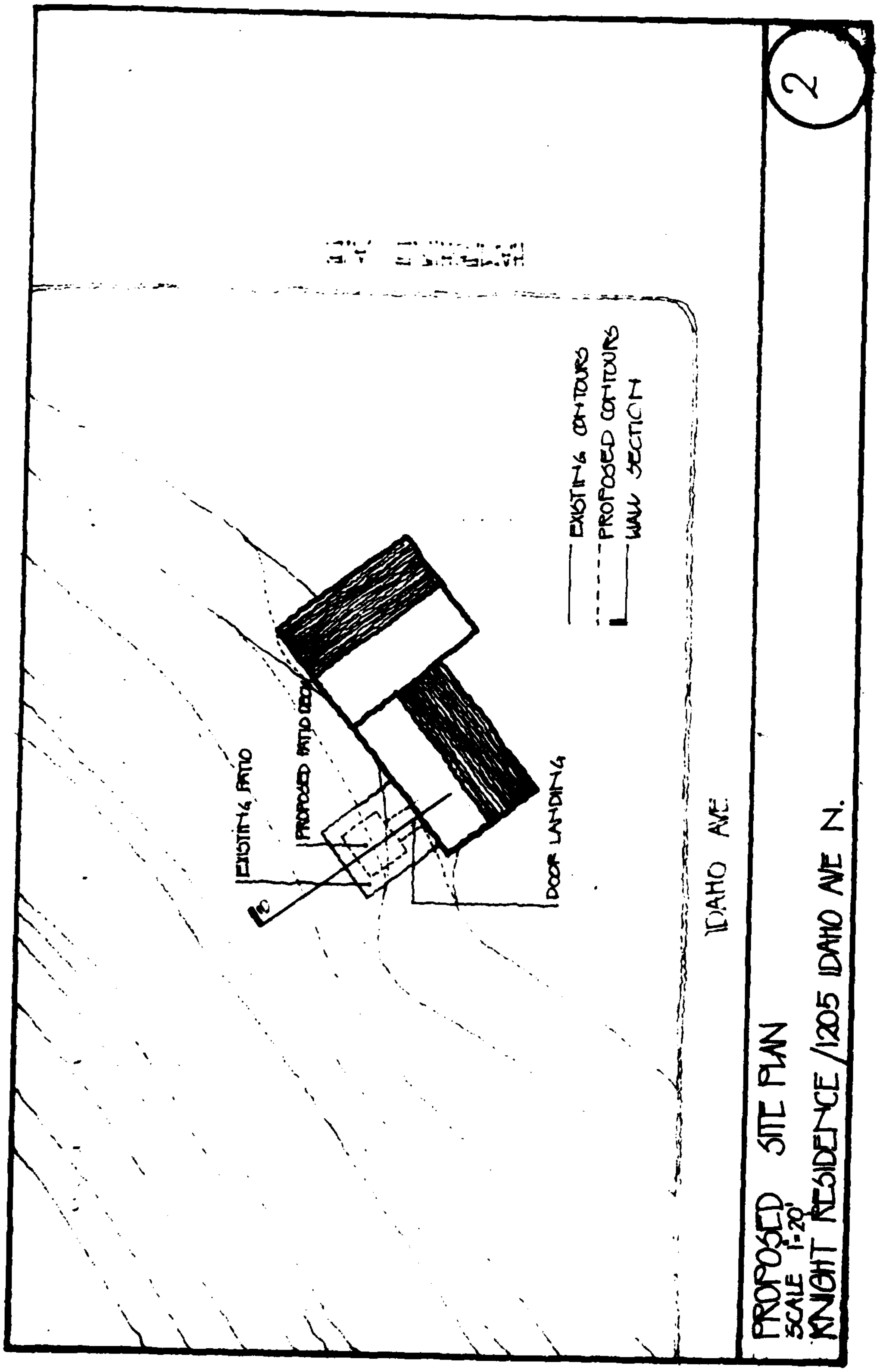
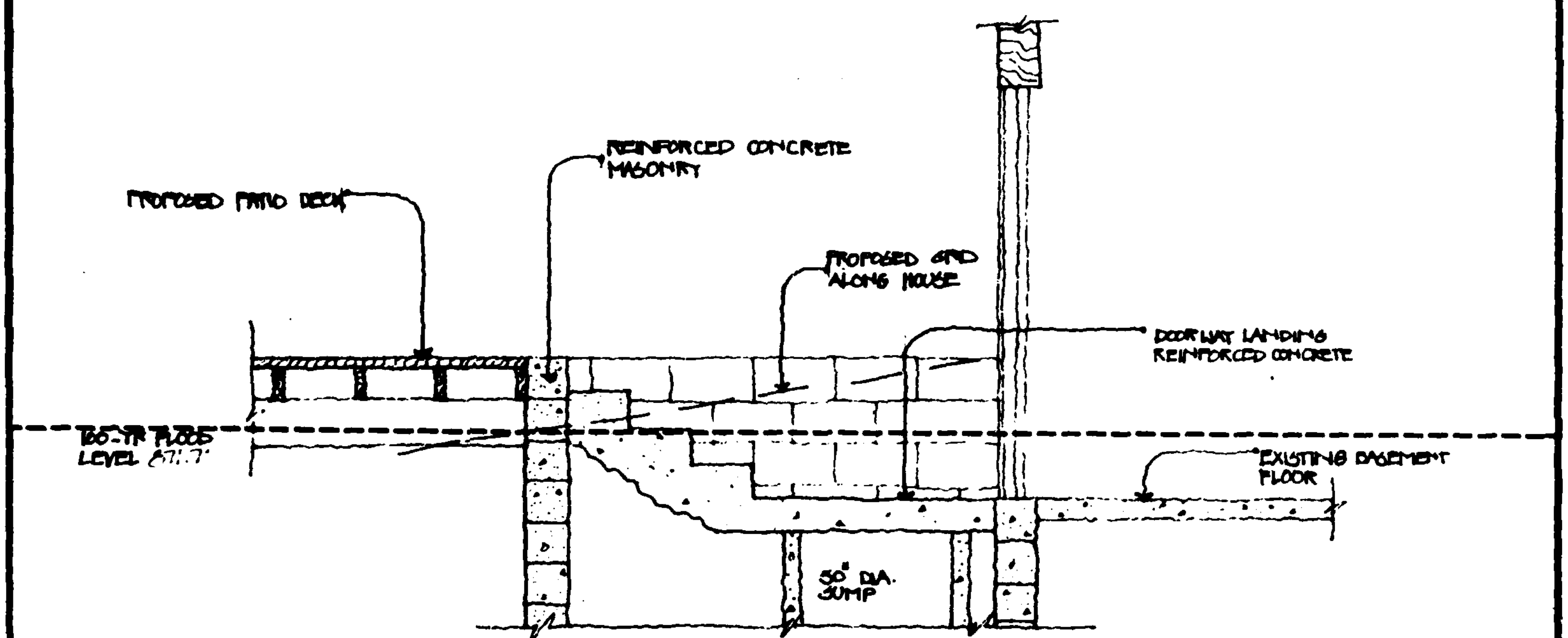


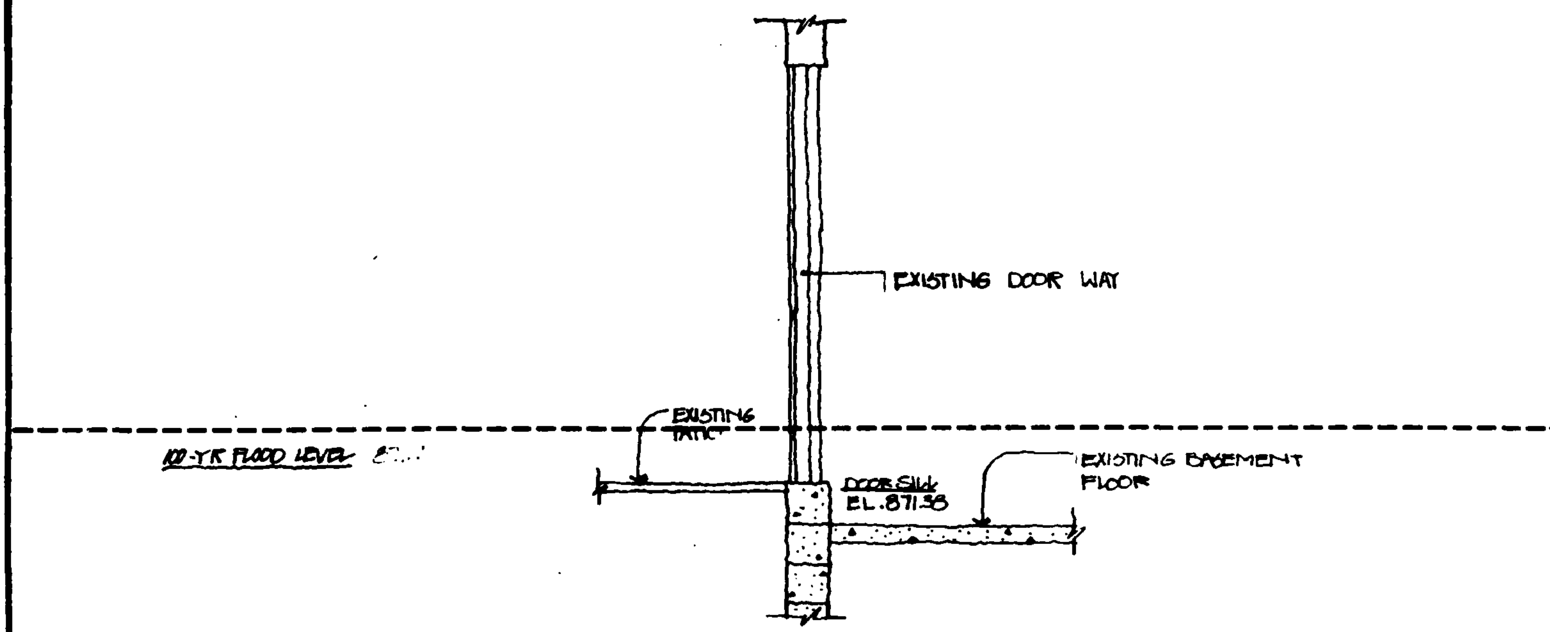
Plate H-43
PLATE H-43



PROPOSED WALL SECTION
SCALE 1/2"=1'
KNIGHT RESIDENCE/1205 IDAHO AVE N.

3

PLATE H-44



EXISTING WALL SECTION
SCALE 1/2"=1'
KNIGHT RESIDENCE / 1205 IDAHO AVE N.

4

Plate H-45

PLATE H-45

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE WEST RESIDENCE LOCATED AT 2425 REGENT AVENUE AND THE STREU RESIDENCE LOCATED AT 2445 REGENT AVENUE, GOLDEN VALLEY, MINNESOTA: THE LOW OPENINGS FOR THESE RESIDENCES ARE 842.6 AND 841.78, RESPECTIVELY. THE 10!-YEAR FLOOD LEVEL IS 843.0. WE MUST FLOOD-PROOF TO A LEVEL OF 844.0

WE HAVE DETERMINED THAT A BERM ACROSS THE REAR YARDS OF BOTH HOMES WITHIN THE WILDLIFE PRESERVE WILL BE THE MOST COST EFFECTIVE SOLUTION. WE WILL THEN PROVIDE A SUMP PUMP TO REMOVE INTERIOR DRAINAGE.

SEE PLATES H-46 AND H-47.

SUMMARY OF ELEVATIONS - 2425 REGENT AVENUE

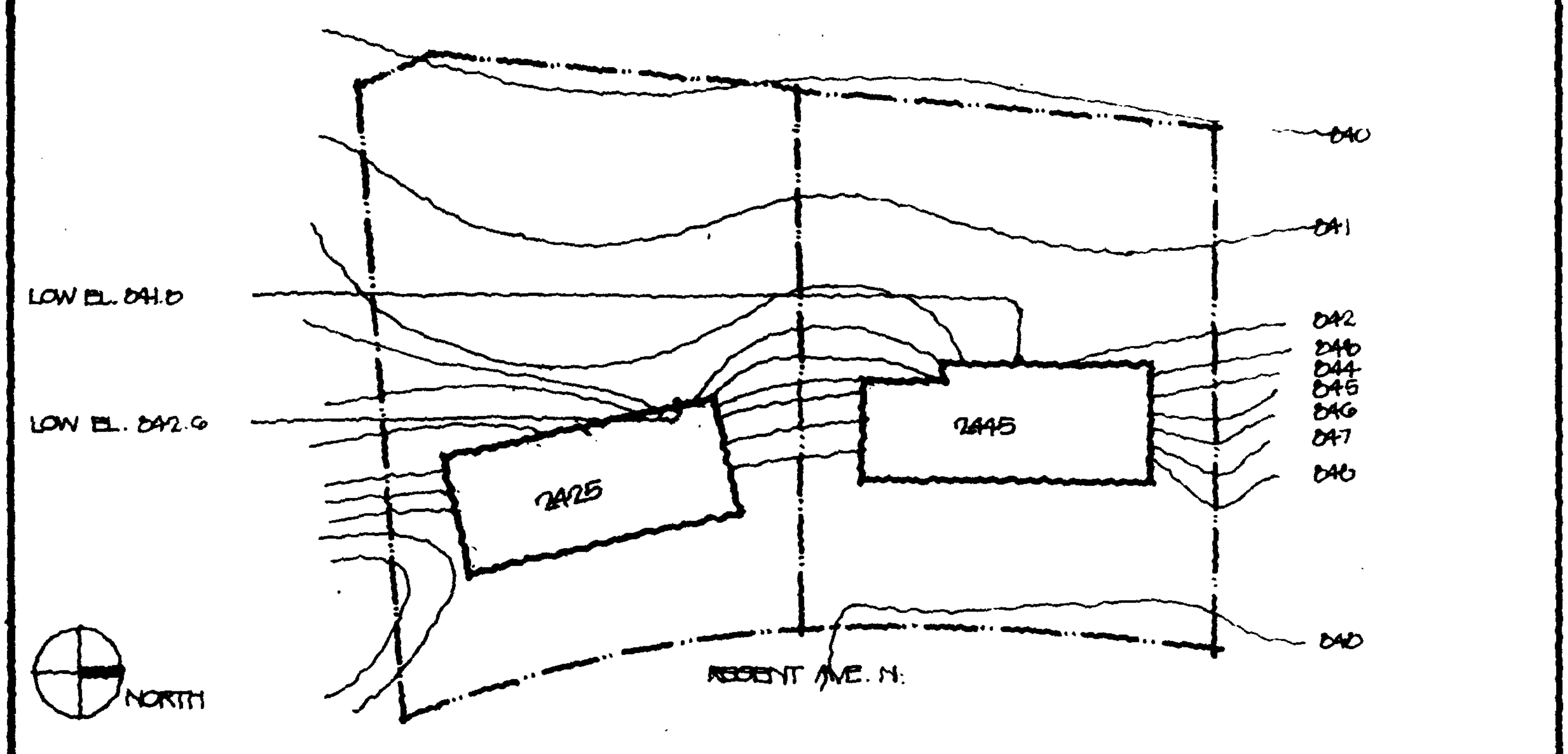
DOOR	842.6
FIRST FLOOR	851.1
100-YEAR FLOOD LEVEL	843.0

SUMMARY OF ELEVATIONS - 2445 REGENT AVENUE

DOOR SILL	841.78
WINDOR SILL	844.13
FIRST FLOOR	849.60
100-YEAR FLOOD LEVEL	843.0

CONSTRUCTION ESTIMATE
2425 AND 2445 REGENT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA

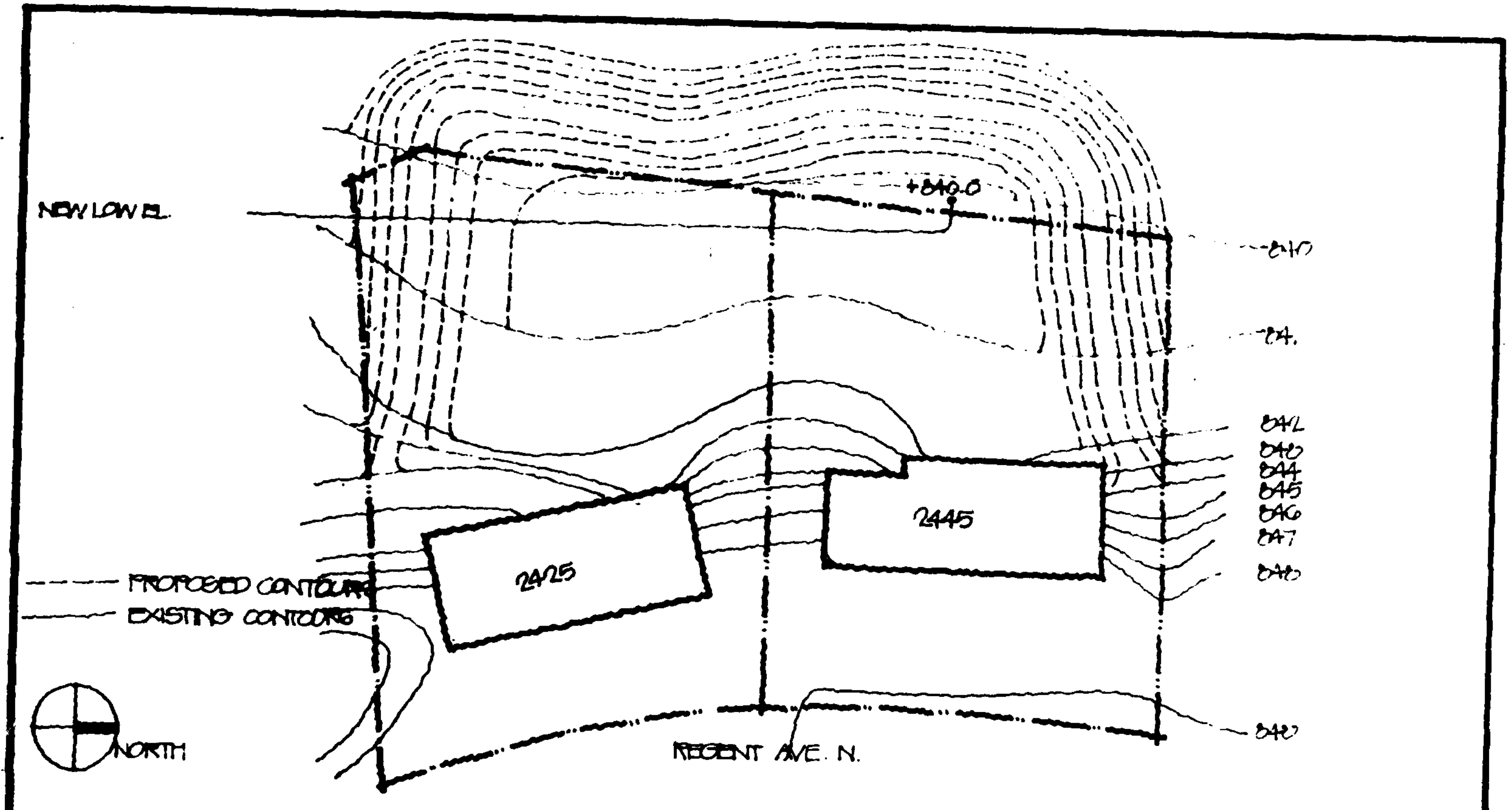
EARTHWORK	
COMMON BORROW	$ 3,550.00
SOD WITH TOPSOIL	2,450.00
SEEDING WITH TOPSOIL	700.00
INTERIOR DRAINAGE	6,050.00
TOTAL ESTIMATE	$12,750.00
OR	$ 6,375.00/HOME



EXISTING SITE PLAN
SCALE: 1"=30'
WEST/STREU RESIDENCE / 2425, 2445 REGENT AVE.

1

PLATE H-46



PROPOSED SITE PLAN
SCALE: 1"=30'
WEST/STREU RESIDENCE / 2425, 2445 REGENT AVE.

2

PLATE H-47

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE POOSTER RESIDENCE LOCATED AT 2545 REGENT AVENUE, AND THE NESBITT RESIDENCE LOCATED AT 2505 REGENT AVENUE, GOLDEN VALLEY, MINNESOTA: THE LOW OPENINGS ARE 842.20 AND 842.51, RESPECTIVELY. THE 100-YEAR FLOOD LEVEL IS 843.0. WE MUST FLOOD-PROOF TO A LEVEL OF 844.0.

THE BEST SOLUTION TO THE FOLLOWING PROBLEMS OF THESE TWO HOMES WOULD BE TO CONSTRUCT A BERM OF TOPSOIL AND THEN TO SOD IT. THE SIMILAR CONTOURS AND LARGE REAR YARDS OF THESE TWO HOMES ADAPT VERY NICELY TO THIS SOLUTION. AN INTERIOR DRAINAGE SYSTEM WITH A SUMP PUMP WOULD ALSO HAVE TO BE CONSTRUCTED IN THIS CASE.

SEE PLATES H-48 AND H-49.

SUMMARY OF ELEVATIONS - 2545 REGENT AVENUE

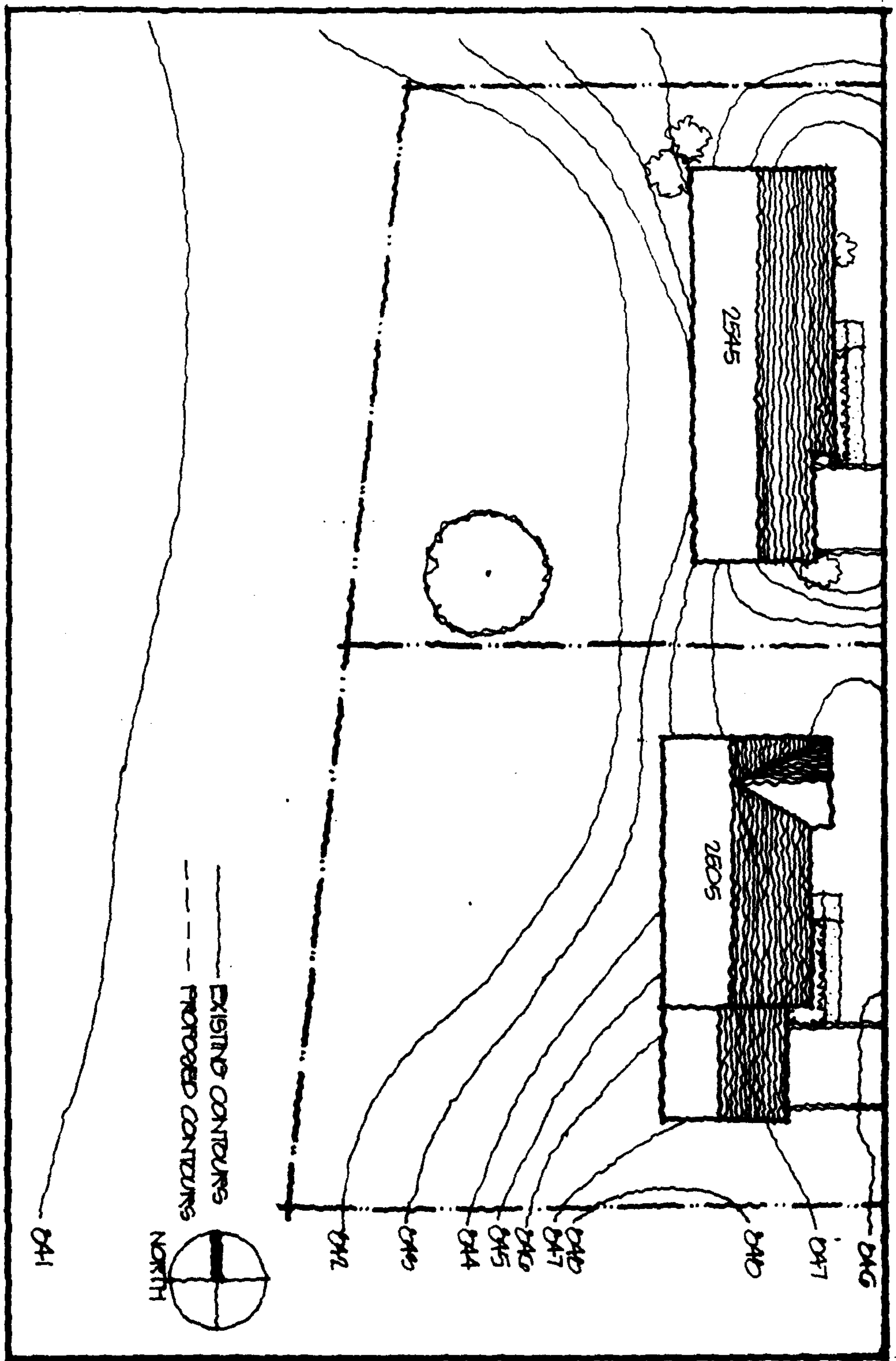
DOOR SILL	842.20
WINDOW SILL	845.00
FIRST FLOOR	850.50

SUMMARY OF ELEVATIONS - 2505 REGENT AVENUE

DOOR SILL (SOUTH DOOR)	842.64
DOOR SILL (NORTH DOOR)	842.51
WINDOW SILL	844.71
FIRST FLOOR	850.60

CONSTRUCTION ESTIMATE
2505 AND 2545 REGENT AVENUE NORTH, GOLDEN VALLEY, MINNESOTA

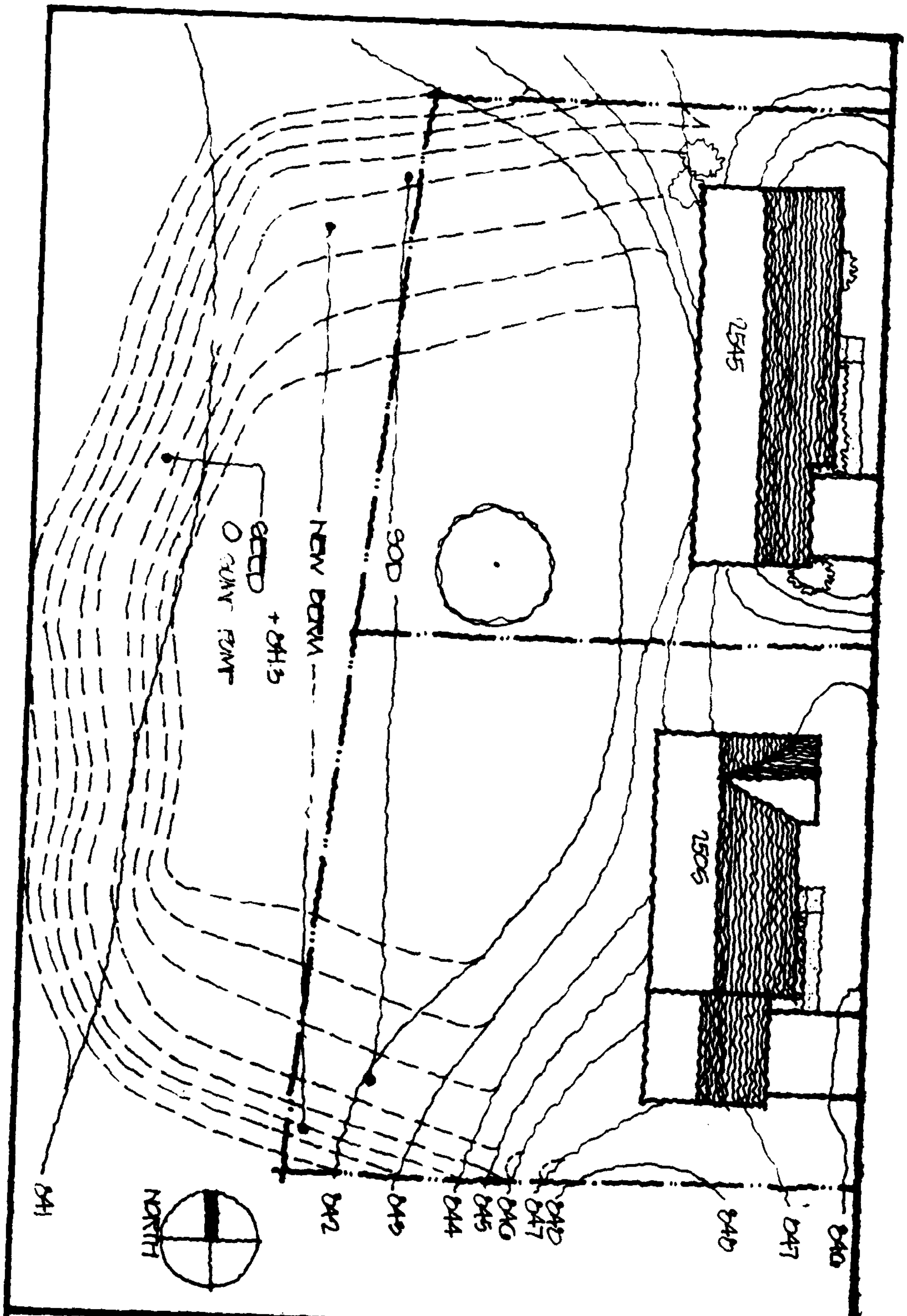
EARTHWORK	
COMMON BORROW	$ 7,350.00
SOD WITH TOPSOIL	3,600.00
SEEDING WITH TOPSOIL	600.00
INTERIOR DRAINAGE	6,050.00
STORM SEWER	4,250.00
TOTAL ESTIMATE	$21,850.00
OR	$10,925.00/HOME



EXISTING SITE PLAN
SCALE: 1"=20'
FLOOSTER & NESBITT RESIDENCE / 2545/2505

1

PLATE H-[illegible]



PROPOSED SITE PLAN / REGENT AVE.
SCALE: 1"=20'
FLOOSTER & NESBITT RESIDENCE / 2545/2505

2

PLATE

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE QUINN RESIDENCE LOCATED AT 3810 BASSETT CREEK DRIVE, GOLDEN VALLEY, MINNESOTA: THE EXISTING ONE HUNDRED YEAR FLOOD LEVEL IS 831.4. THE PROPOSED ONE HUNDRED YEAR FLOOD LEVEL IS 830.7. THE LOW OPENING FOR THE RESIDENCE IS 829.44. WE MUST FLOOD-PROOF TO A LEVEL OF 831.7, WHICH IS ONE FOOT ABOVE THE ONE HUNDRED YEAR FLOOD LEVEL.

THE SOIL CONDITIONS UPON WHICH THE QUINN RESIDENCE RESTS ARE NOT SUITABLE FOR THE CONSTRUCTION OF A CONCRETE BLOCK WALL SECTION BUT PROVIDE SUITABLE CHARACTERISTICS FOR CONSTRUCTION OF A TIMBER WALL. THE HOME IS CONSTRUCTED ON PILINGS. THE GRADE AT THE REAR OF THE SITE SLOPES AWAY FROM THE RESIDENCE TOWARD THE CREEK. THE DISTANCE FROM THE HOME TO THE CREEK IS SHORT.

THE POOR SOIL CONDITIONS COMBINED WITH THE RELATIVELY SHORT DISTANCE FROM THE HOME TO THE CREEK ELIMINATES THE USE OF A BERM TO SOLVE THE FLOODING PROBLEM. WE RECOMMEND THE USE OF A TIMBER WALL AROUND THE REAR OF THIS HOME AND 3820 BASSETT CREEK DRIVE TYING INTO THE HIGH GROUND AT THE ENDS OF THE COMMON WALL. WE WILL PROVIDE A COMMON SUMP PUMP PIT TO REMOVE THE INTERNAL DRAINAGE WATER FOR 3810 AND 3820 BASSETT CREEK DRIVE.

SEE PLATES H-50 THROUGH H-53 AND PLATE H-57.

THE BERKSETH/KEMPF RESIDENCE LOCATED AT 3820 BASSETT CREEK DRIVE, GOLDEN VALLEY, MINNESOTA: THE EXISTING ONE HUNDRED YEAR FLOOD LEVEL IS 831.4. THE PROPOSED ONE HUNDRED YEAR FLOOD LEVEL IS 830.7. THE LOW OPENING ELEVATION OF THE RESIDENCE IS 829.94. WE MUST FLOOD-PROOF TO A LEVEL OF 831.7, WHICH 1.76 FEET ABOVE THE LOW OPENING.

THE SOIL CONDITIONS AT THE BERKSETH/KEMPF RESIDENCE ARE NOT SUITABLE FOR THE CONSTRUCTION OF A CONCRETE BLOCK WALL, BUT PROVIDE SUITABLE CHARACTERISTICS FOR THE CONSTRUCTION OF A TIMBER WALL. THE HOME IS BUILT UPON PILINGS. THE SITE HAS MANY LARGE TREES AND IS RELATIVELY CLOSE TO THE CREEK IN THE REAR YARD. WE FEEL THAT THE POOR SOIL, THE NARROW REAR YARD, AND THE TREES ELIMINATE THE USE OF A BERM.

WE PROPOSED TO SOLVE THE PROBLEM WITH THE CONSTRUCTION OF A TIMBER WALL. ONE SET OF STEPS WOULD BE CONSTRUCTED TO PROVIDE ACCESS OVER THE WALL. A SUMP PUMP PIT WITH A SUBMERSIBLE SUMP PUMP WILL BE CONSTRUCTED BEHIND THE WALL TO REMOVE ANY INTERNAL DRAINAGE WATER FOR 3810 AND 3820 BASSETT CREEK DRIVE.

SEE PLATES H-54 THROUGH H-57.

SUMMARY OF ELEVATIONS - 3810 BASSETT CREEK DRIVE

LOWER DOOR	829.53
WINDOW	831.75
DECK	837.94
LOWER FLOOR	829.44
100 YEAR FLOOD LEVEL	830.4
FLOOD-PROOFING LEVEL	831.4

SUMMARY OF ELEVATIONS - 3820 BASSETT CREEK DRIVE

LOWER LEVEL FLOOR	829.94
LOWER LEVEL DOOR	829.99
WINDOW SILL	833.00
UPPER LEVEL	838.41
100 YEAR FLOOD LEVEL (PROPOSED)	830.7
100 YEAR FLOOD LEVEL (EXISTING)	831.4

CONSTRUCTION ESTIMATE:
3810 AND 3820 BASSETT CREEK DRIVE

EARTHWORK	
EXCAVATION AND BACKFILL	$ 4,400.00
SOD WITH TOPSOIL	2,000.00
CARPENTRY	
TIMBER WALL	17,550.00
STEPS	675.00
DRAINAGE	
SUMP PUMP WITH SUMP	6,050.00
DRAINTILE WITH FILTER	2,200.00
TOTAL ESTIMATE	$32,875.00
OR	$16,437.50/HOME

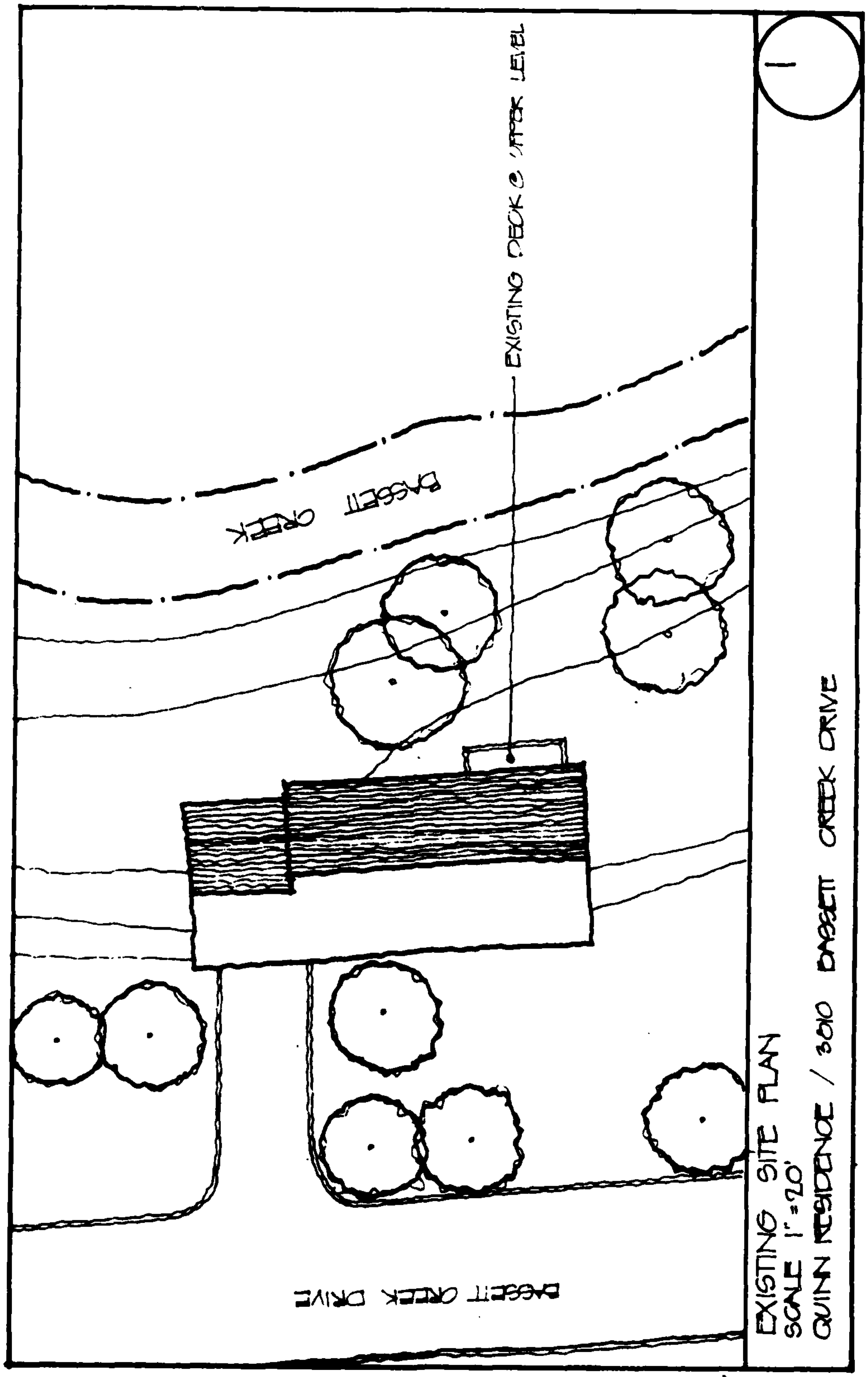
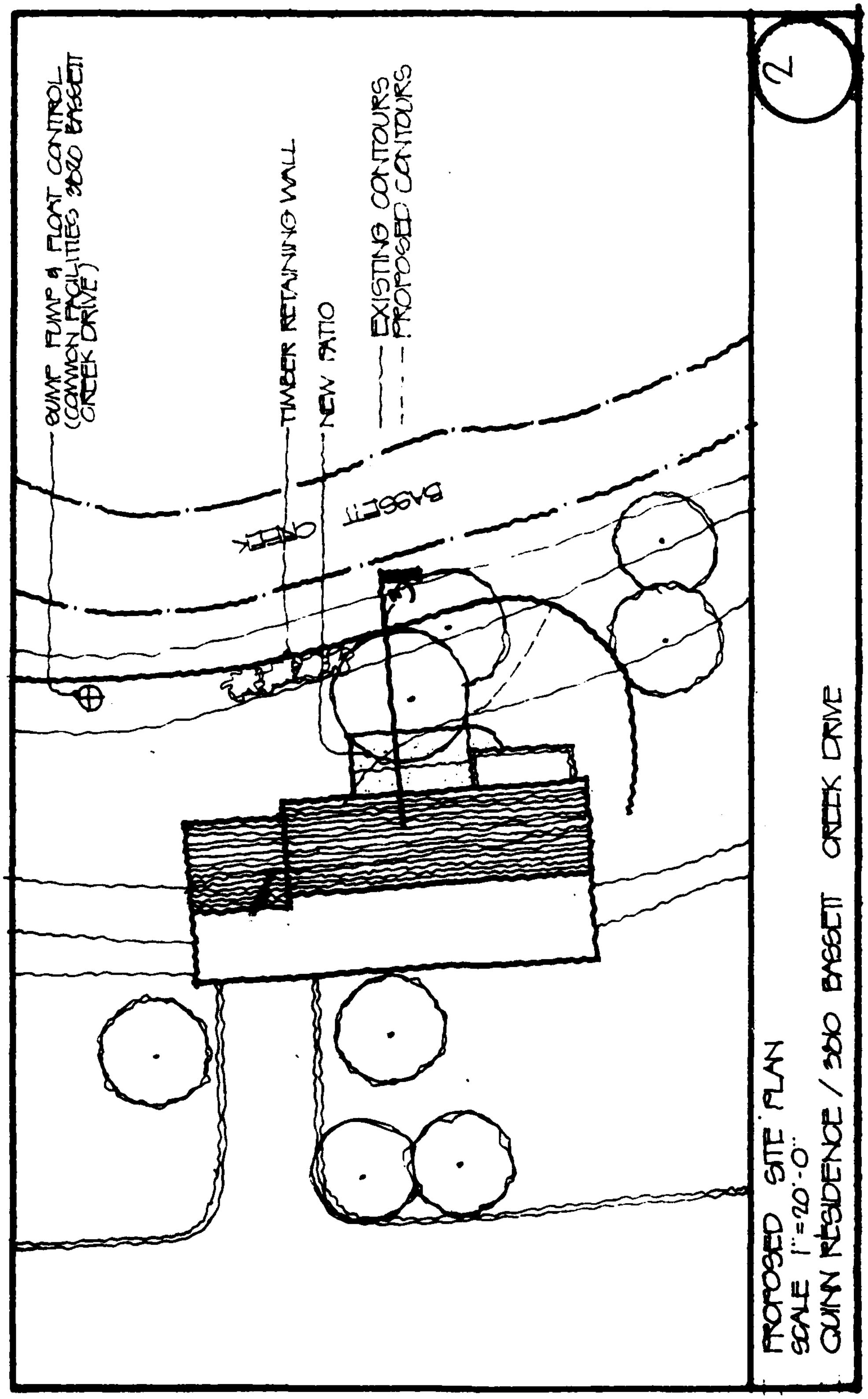
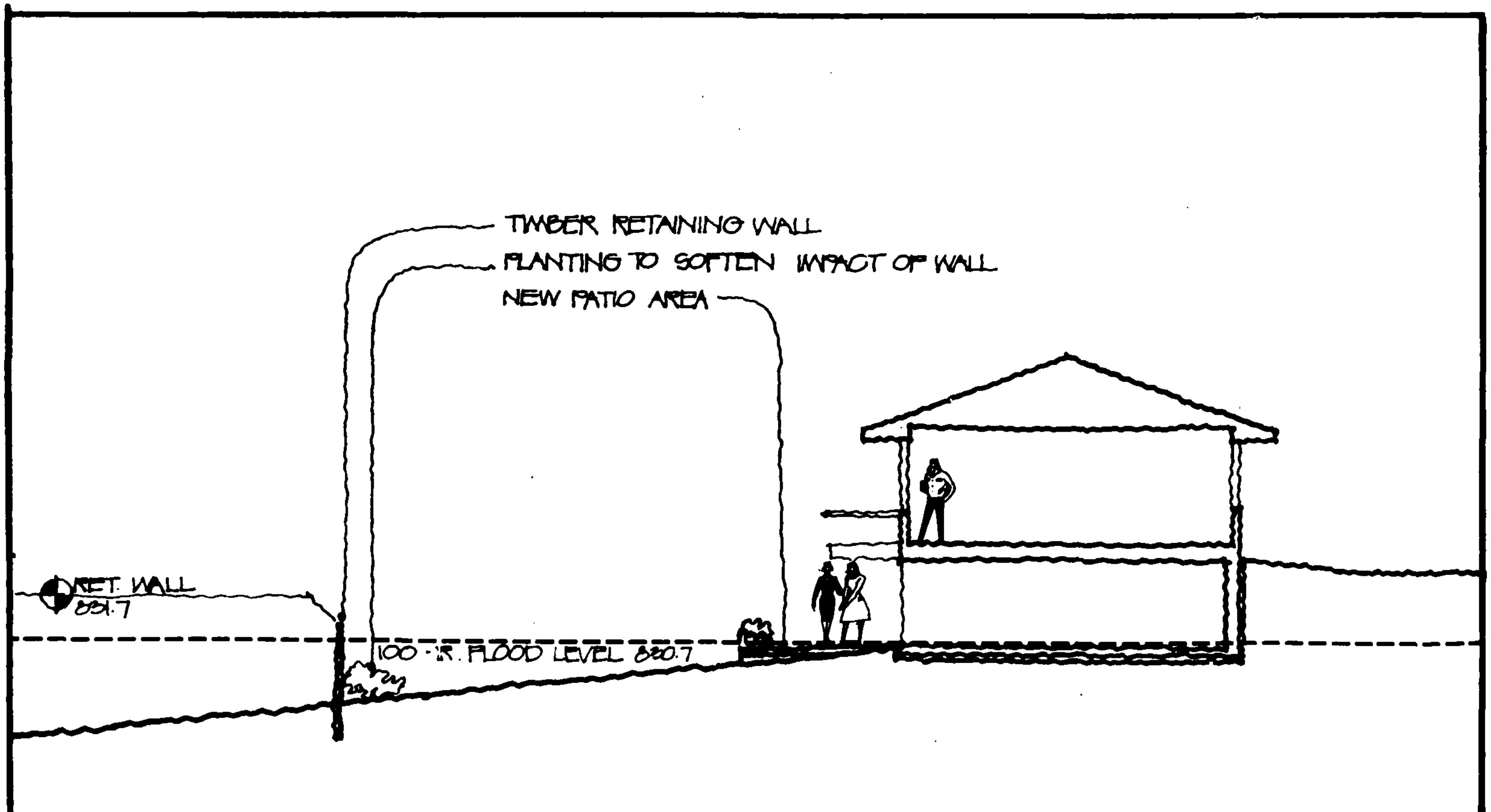


Plate H-50
PLATE H-50



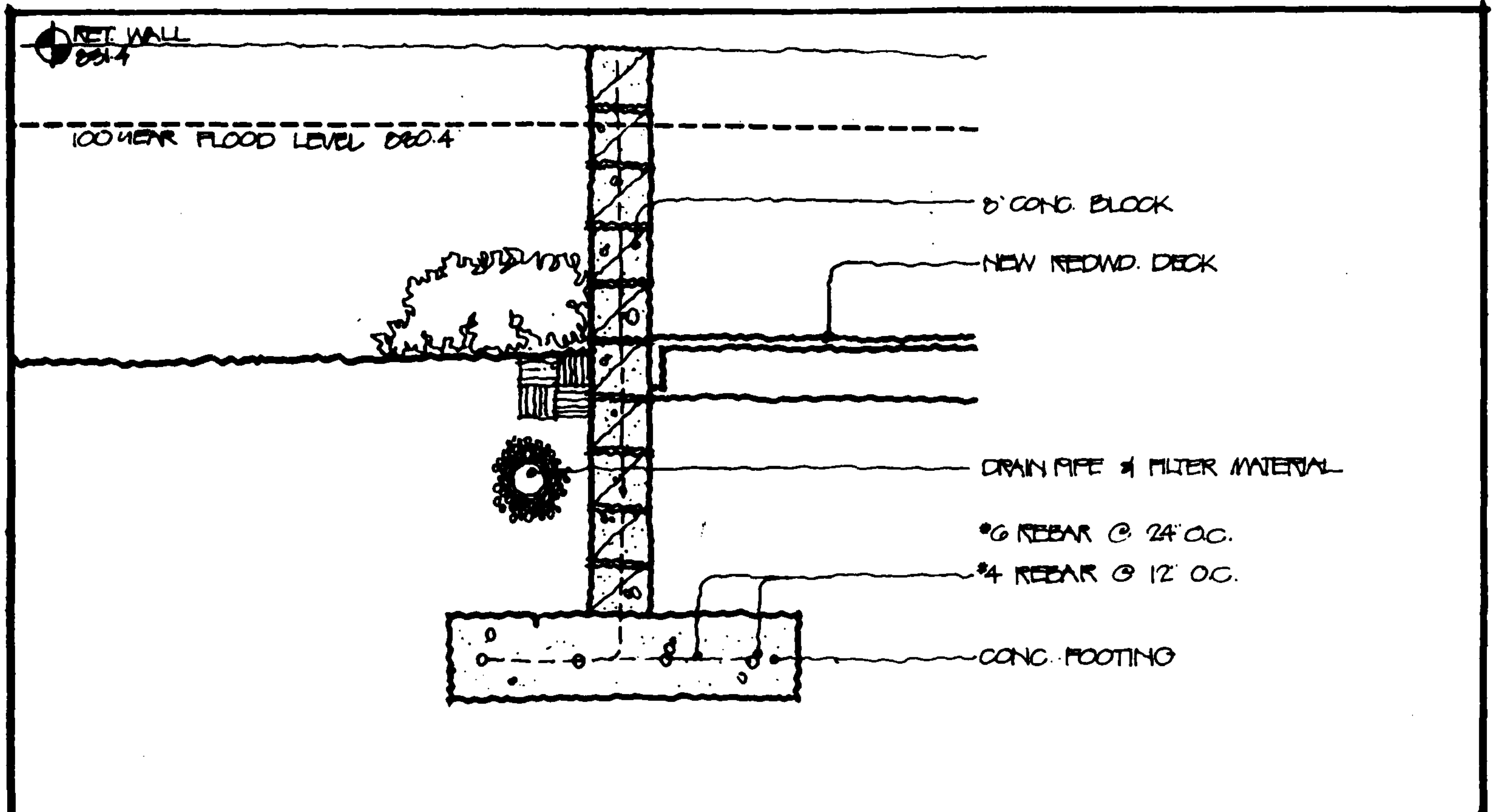
H-51
PLATE H-51



SECTION
SCALE: 1/8" = 1'-0"
QUINN RESIDENCE / 5010 BASSETT CREEK DRIVE

3

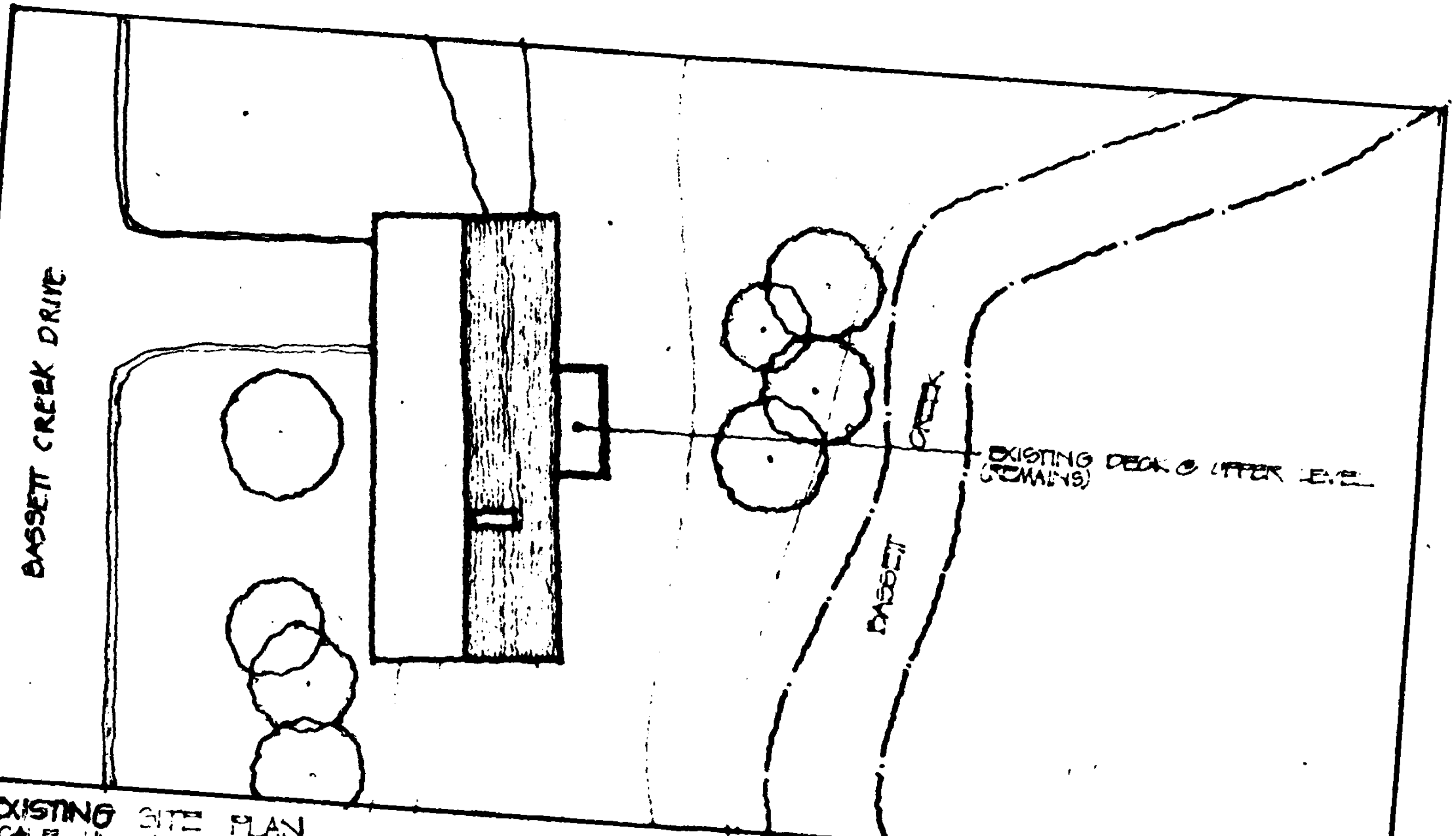
PLATE H-52



WALL SECTION
SCALE: 3/4" = 1'-0"
QUINN RESIDENCE/ 3010 BASSETT CREEK DRIVE

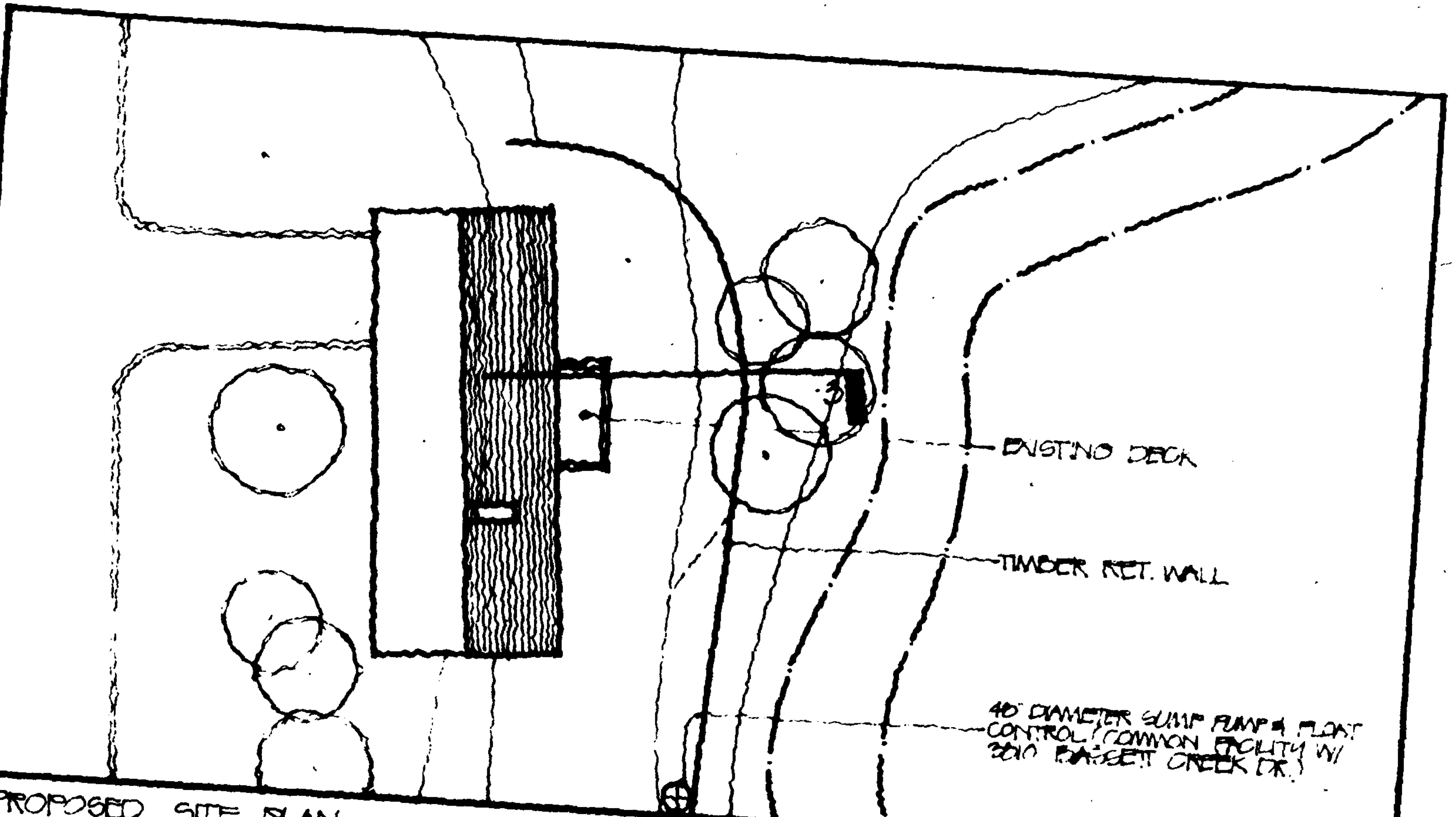
4

PLATE H-53



EXISTING SITE PLAN
SCALE 1" = 20'
BERSETH RESIDENCE / 3620 BASSETT CREEK DRIVE

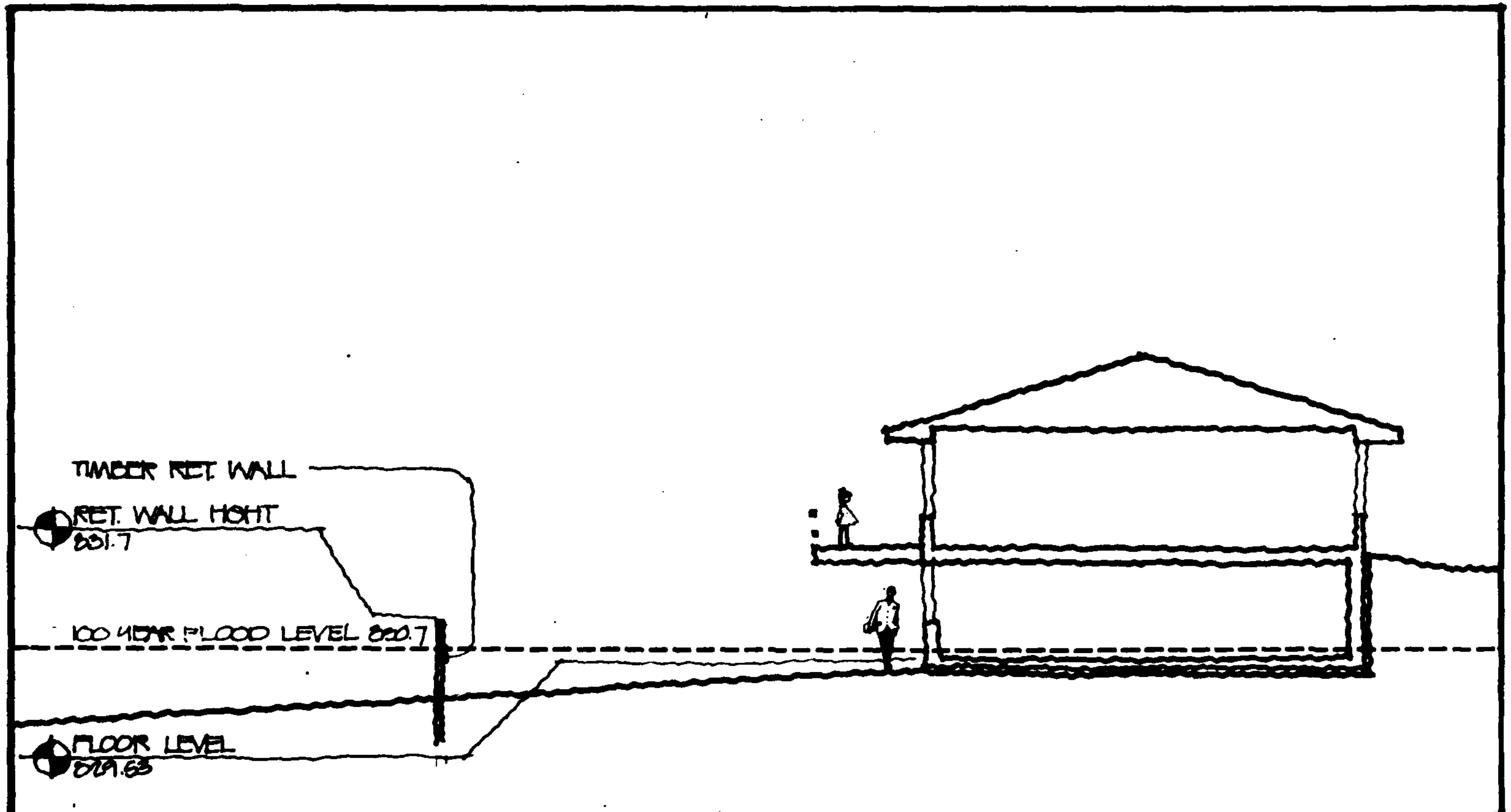
PLATE H-86



PROPOSED SITE PLAN
SCALE 1"=20'
BERSETH RESIDENCE / 3020 BASSETT CREEK DRIVE

2

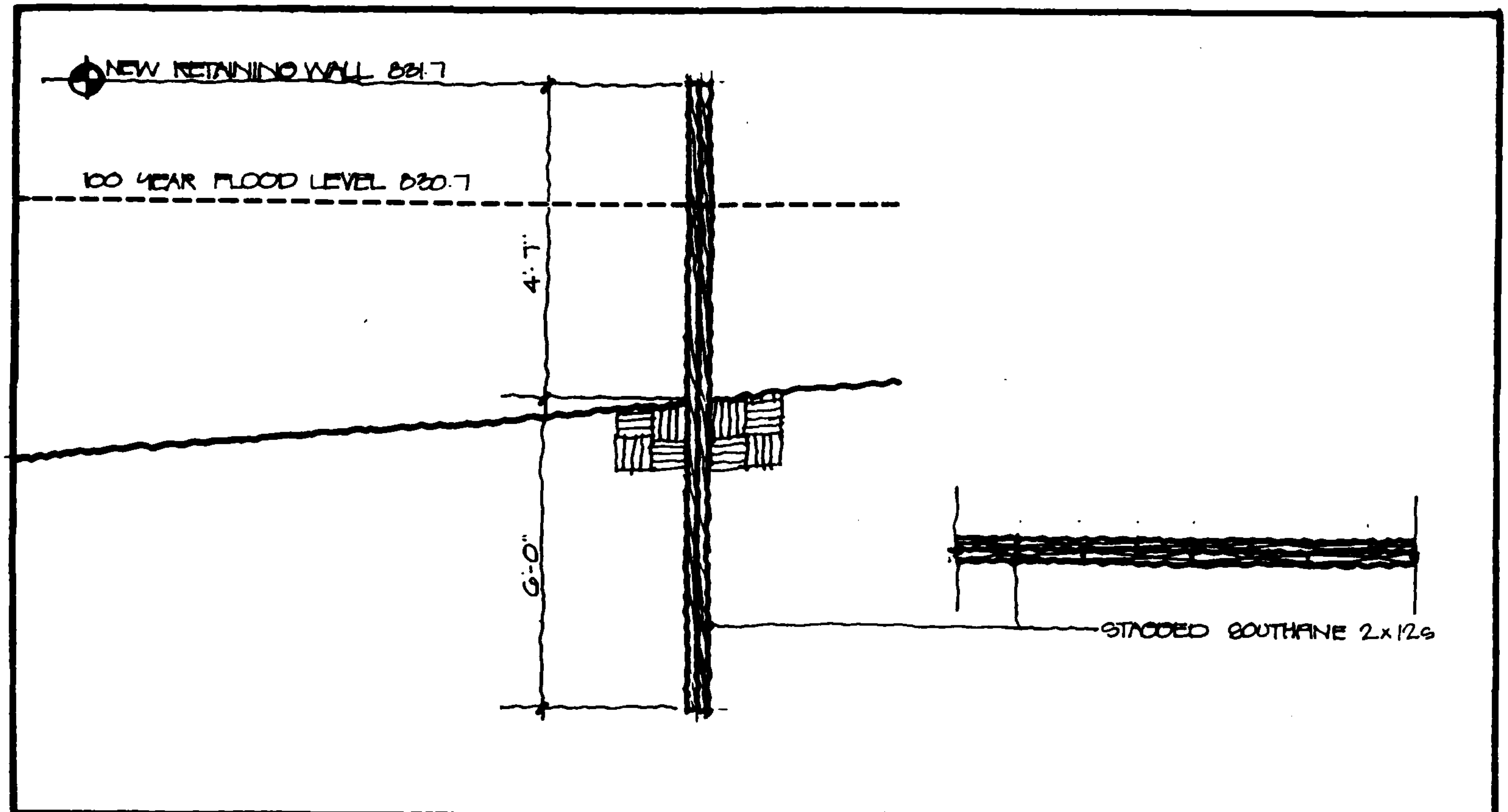
PLATE H-55



SECTION
SCALE : 1/8" = 1'-0"
BERKSETH RESIDENCE / 3620 BASSETT CREEK DRIVE

3

PLATE H-56



WALL SECTION
SCALE 1"=1'-0"
BERKSETH / QUINN / 3020 · 3010 BASSETT CREEK DRIVE

4

PLATE H-57

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE MOLLER RESIDENCE LOCATED AT 4975 BASSETT CREEK DRIVE, GOLDEN VALLEY, MINNESOTA: THE LOW OPENING OF THIS HOME IS 841.14. THE 100-YEAR FLOOD LEVEL IS 841.7. WE MUST FLOOD-PROOF TO A LEVEL OF 842.7.

THE REAR YARD OF THE RESIDENCE IS NOT DEEP ENOUGH TO ALLOW FOR THE CONSTRUCTION OF A BERM. THE CITY SANITARY SEWER ALSO RUNS THROUGH THE REAR YARD. THEREFORE, THE BEST SOLUTION TO THE PROBLEM IS TO CONSTRUCT A RETAINING WALL OF CONCRETE BLOCK AROUND THE REAR OF THE HOME, TYING IT INTO THE EXISTING TOPOGRAPHY AT THE SIDES. WE MUST THEN CONSTRUCT AN INTERIOR DRAINAGE SYSTEM WITH A SUMP PUMP TO HANDLE INTERIOR DRAINAGE.

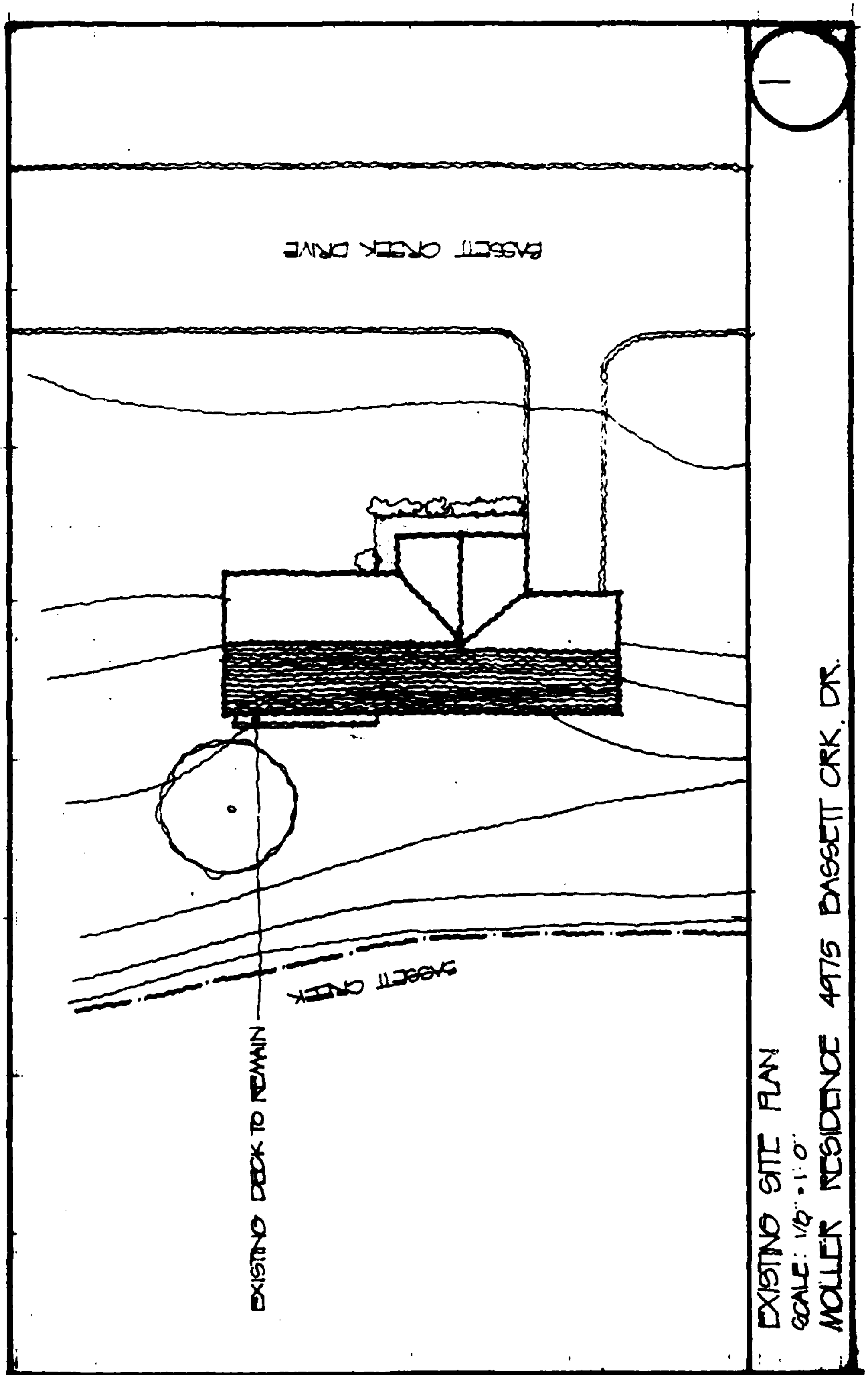
SEE PLATES H-58 THROUGH H-61.

SUMMARY OF ELEVATIONS

DOOR SILL	841.14
WINDOW SILL	844.02
TOP OF DECK	848.88
100-YEAR FLOOD LEVEL	841.7
FLOOD-PROOF LEVEL	843.1

CONSTRUCTION ESTIMATE:
4975 BASSETT CREEK DRIVE, GOLDEN VALLEY, MINNESOTA

EARTHWORK	
EXCAVATION AND BACKFILL	$ 1,000.00
SOD WITH TOPSOIL	675.00
CONCRETE AND MASONRY	
REINFORCED CONCRETE	3,600.00
REINFORCED MASONRY	2,000.00
DRAINAGE	
SUMP PUMP WITH SUMP	6,050.00
DRAINTILE WITH FILTER	800.00
TOTAL ESTIMATE	$14,125.00



H-59
PLATE H-58

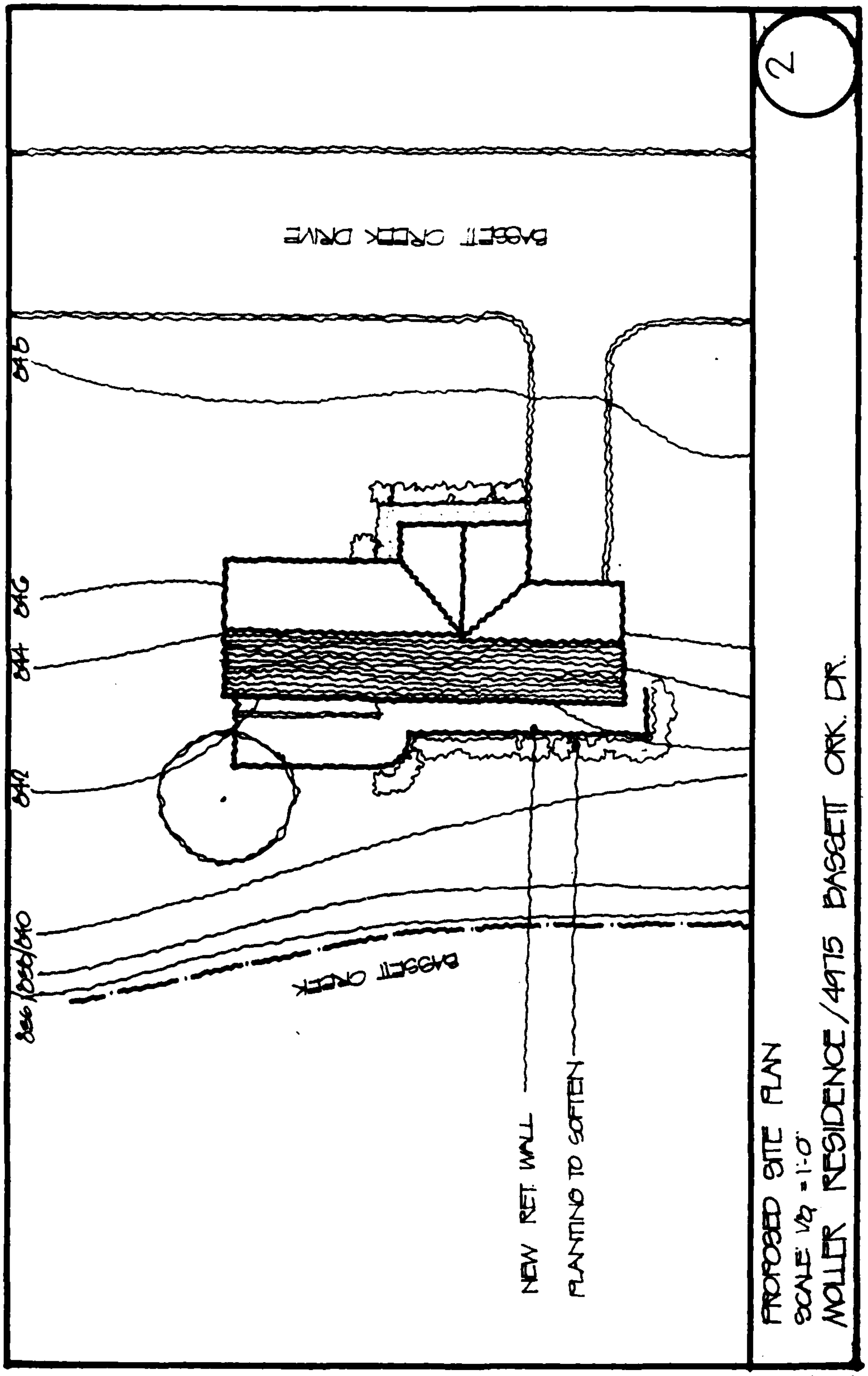
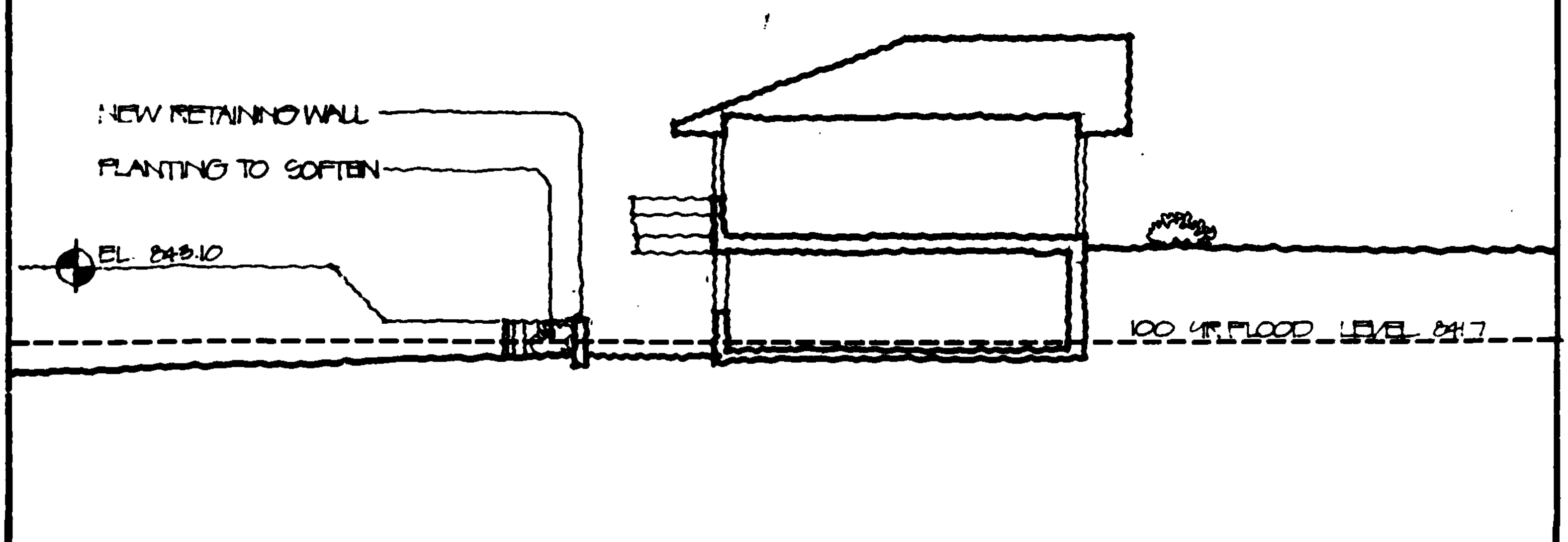

PROPOSED SITE PLAN
SCALE: 1/8 = 1'-0"
MOLLER RESIDENCE / 4975 BASSETT CRK. DR.
NEW RET. WALL
PLANTING TO SOFTEN
BASSETT CREEK DRIVE
BASSETT CREEK
846
846
844
842
2

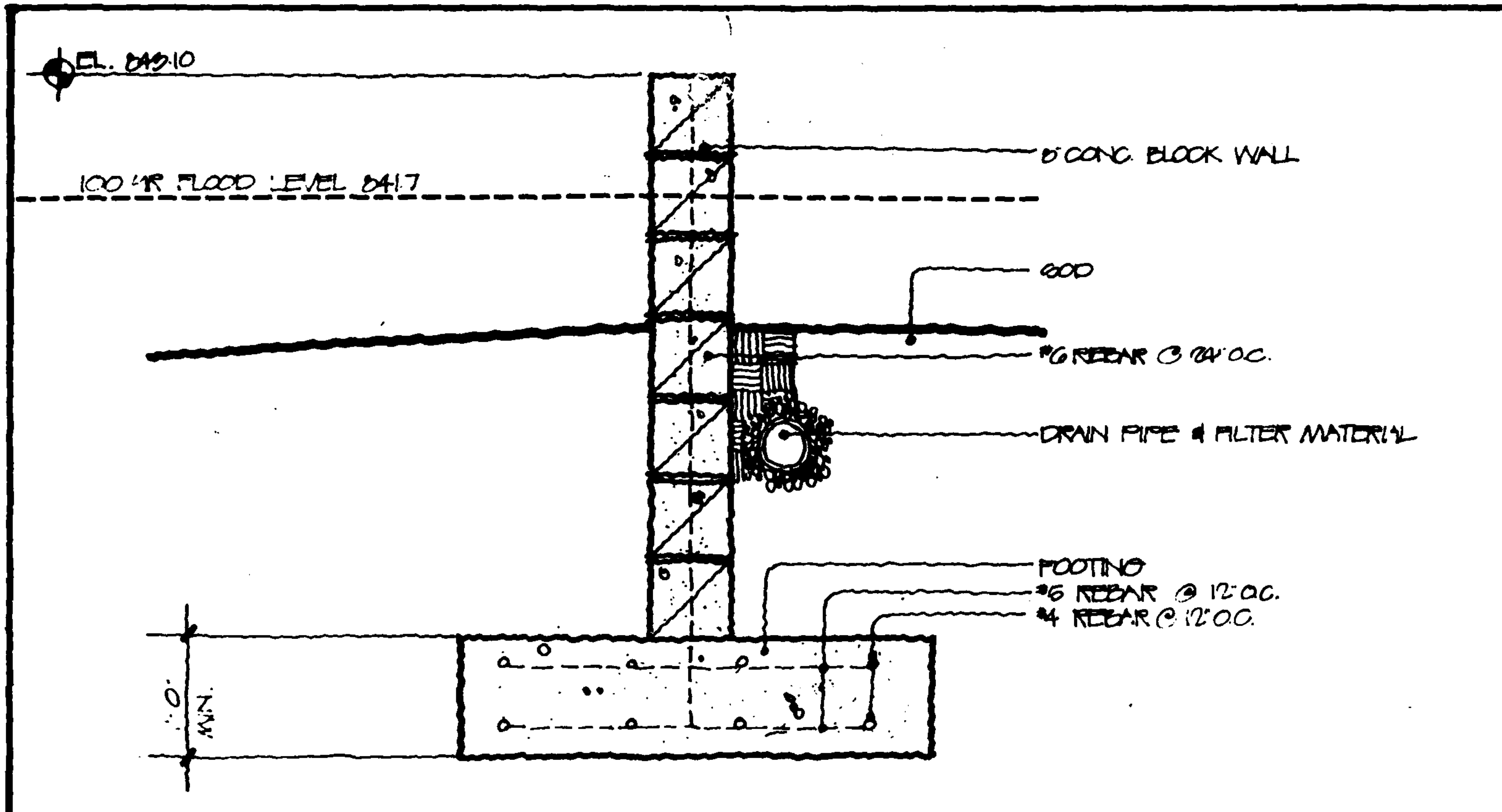
PLATE H-59



BUILDING SECTION
SCALE: 1/8" = 1'-0"
MOLLER RESIDENCE/4975 BASSETT CRK' DRIVE

3

PLATE H-60



WALL SECTION
SCALE: 1" = 1'-0"
MOLLER RESIDENCE / 4975 BASSETT CRK. DR.

4

PLATE H-61

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE GUENTHER RESIDENCE LOCATED AT 5005 BASSETT CREEK DRIVE, GOLDEN VALLEY, MINNESOTA: THE LOW OPENING FOR THE HOME IS 840.75. THE 100-YEAR FLOOD LEVEL IS 841.7. WE MUST FLOOD-PROOF TO A LEVEL AT LEAST 1 FOOT ABOVE THE 100-YEAR LEVEL, WHICH WOULD BE TWO COURSES OF BLOCK, OR AN ELEVATION OF 842.8.

THE REAR YARD OF THE RESIDENCE IS DEEP ENOUGH TO ALLOW THE CONSTRUCTION OF A BERM, HOWEVER, THE SLOPE FROM THE HOUSE WOULD REQUIRE SUCH A BERM TO BE QUITE HIGH. ALSO, THE LOT HAS A NUMBER OF LARGE TREES WHICH WOULD COMPLICATE THE CONSTRUCTION OF A BERM. ALSO, THE CITY SANITARY SEWER RUNS THROUGH THE REAR YARD AND WOULD NOT WITHSTAND THE WEIGHT OF A BERM WITHOUT MODIFICATION. AS A RESULT, WE ARE PROPOSING TO CONSTRUCT A CONCRETE BLOCK RETAINING WALL ALONG THE REAR OF THE HOME. WE WOULD HAVE TO VARY THE WALL TO SAVE ONE LARGE TREE NEAR THE HOUSE AS INDICATED ON THE PLANS.

AN INTERIOR DRAINAGE SYSTEM WILL BE PROVIDED.

SEE PLATES H-63 THROUGH H-65

SUMMARY OF ELEVATIONS

DOOR SILL	840.75
WINDOW SILL	844.81
TOP OF DECK	848.10
WINDOW SILL	842.83
DOOR SILL	840.81
100-YEAR FLOOD LEVEL	841.7
FLOOD-PROOFING LEVEL	842.8

CONSTRUCTION ESTIMATE:
5005 BASSETT CREEK DRIVE, GOLDEN VALLEY, MINNESOTA

EARTHWORK	
EXCAVATION AND BACKFILL	$ 1,000.00
SOD WITH TOPSOIL	675.00
CONCRETE AND MASONRY	
REINFORCED CONCRETE	3,600.00
REINFORCED MASONRY	2,500.00
DRAINAGE	
SUMP PUMP WITH SUMP	6,050.00
DRAINTILE WITH FILTER	800.00
TOTAL ESTIMATE	$14,625.00

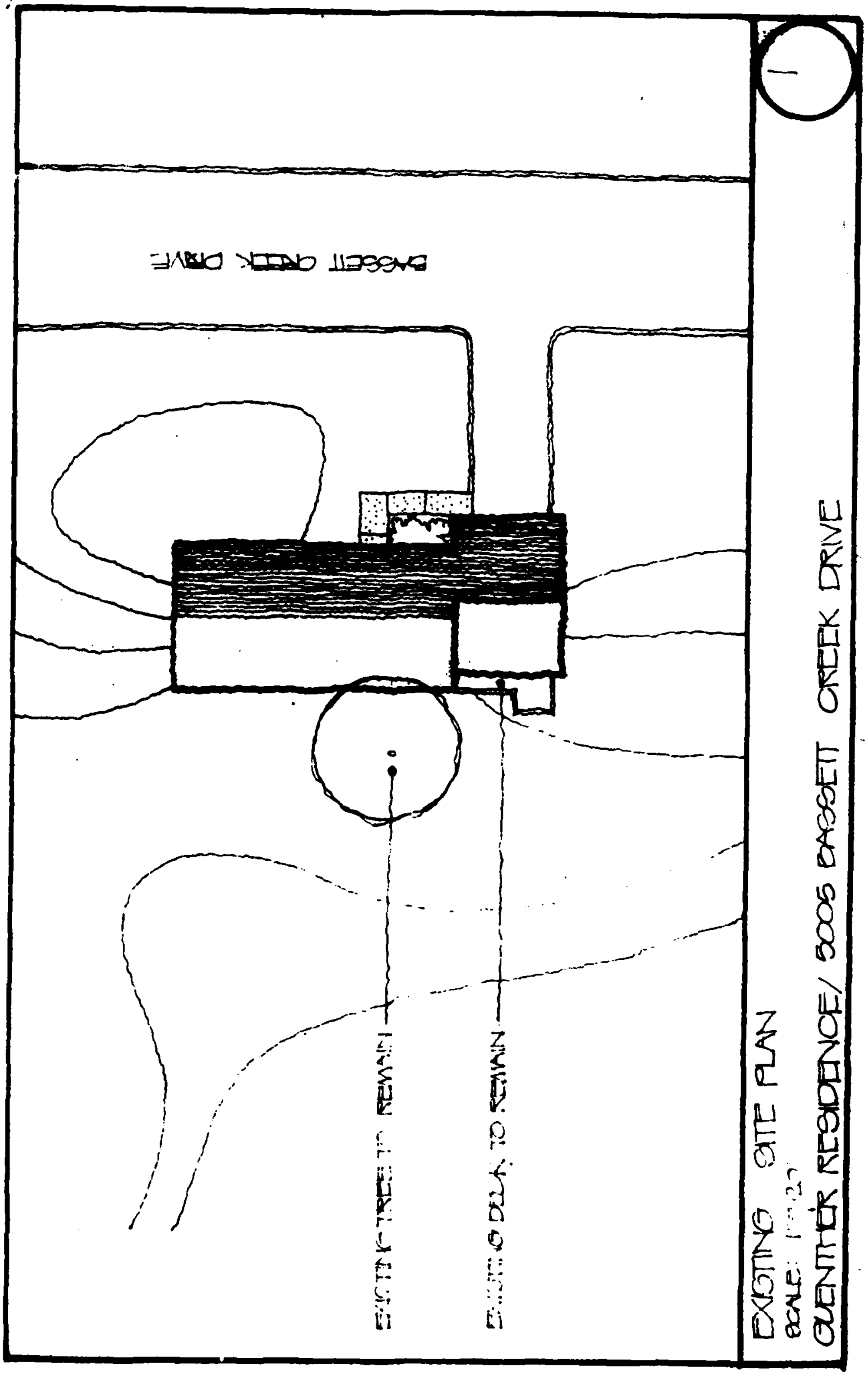
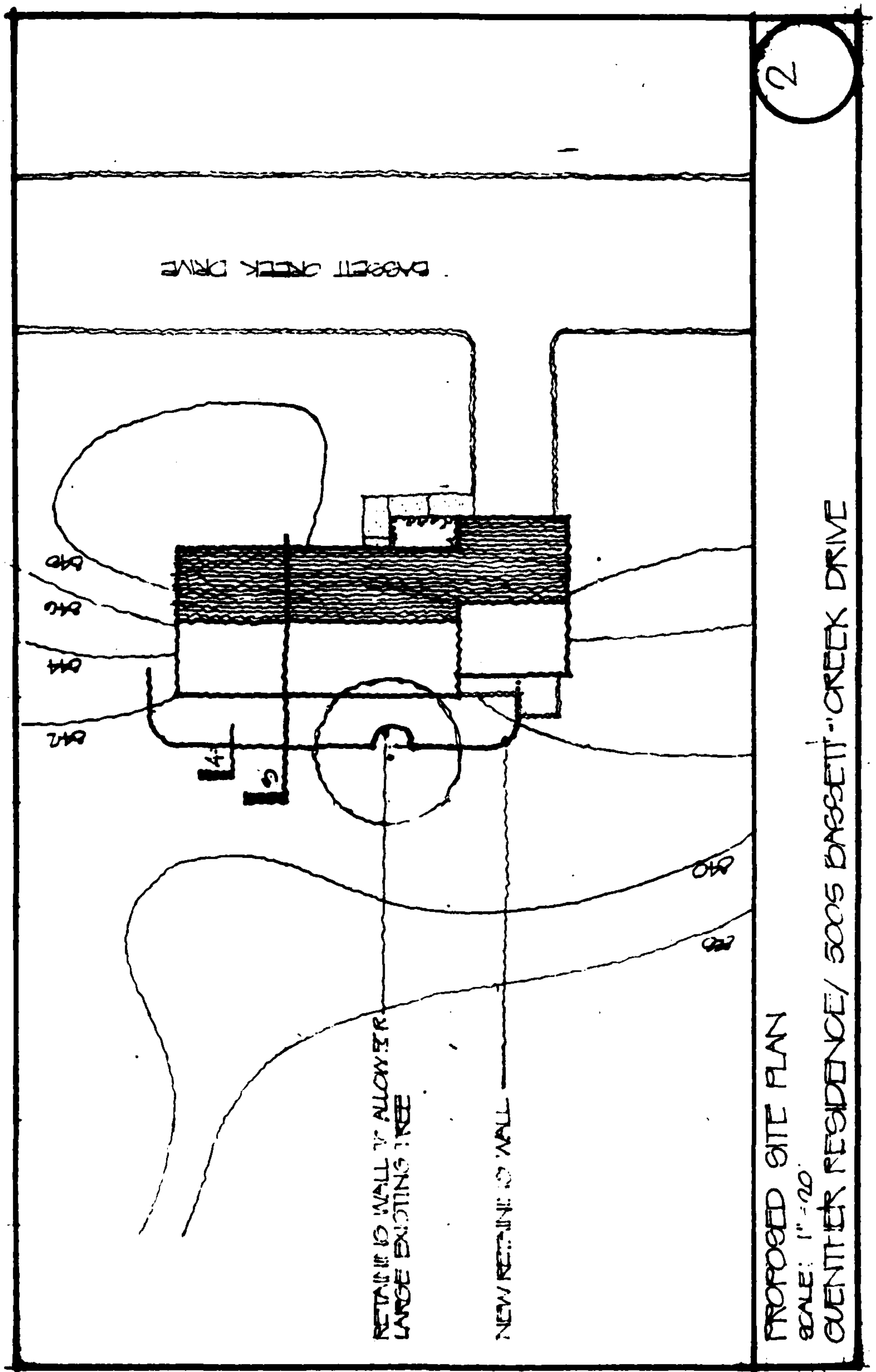
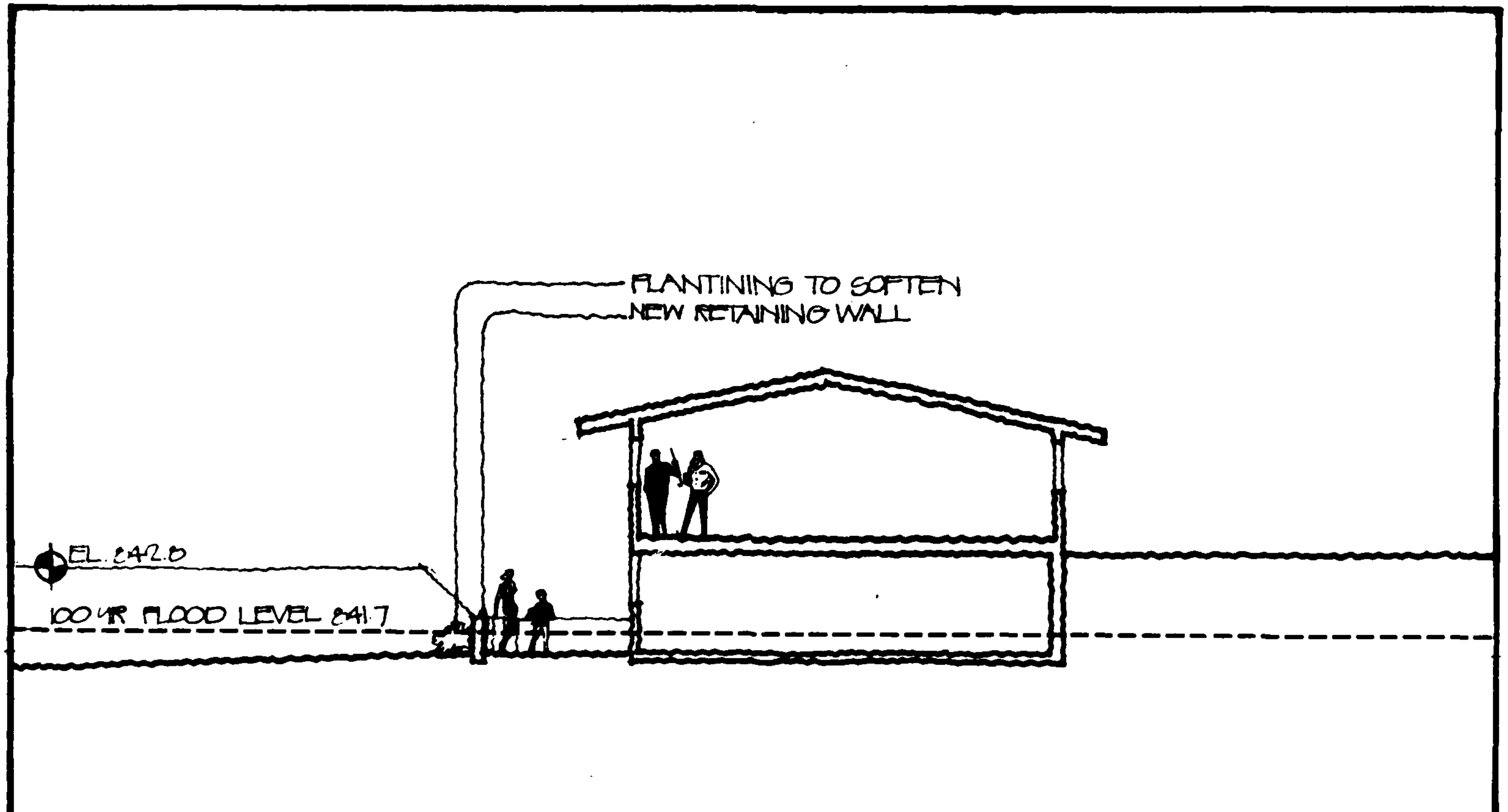

BASSETT CREEK DRIVE
EXISTING TREE TO REMAIN
EXISTING DECK TO REMAIN
EXISTING SITE PLAN
SCALE:
GUENTHER RESIDENCE/ 3005 BASSETT CREEK DRIVE

PLATE H-62



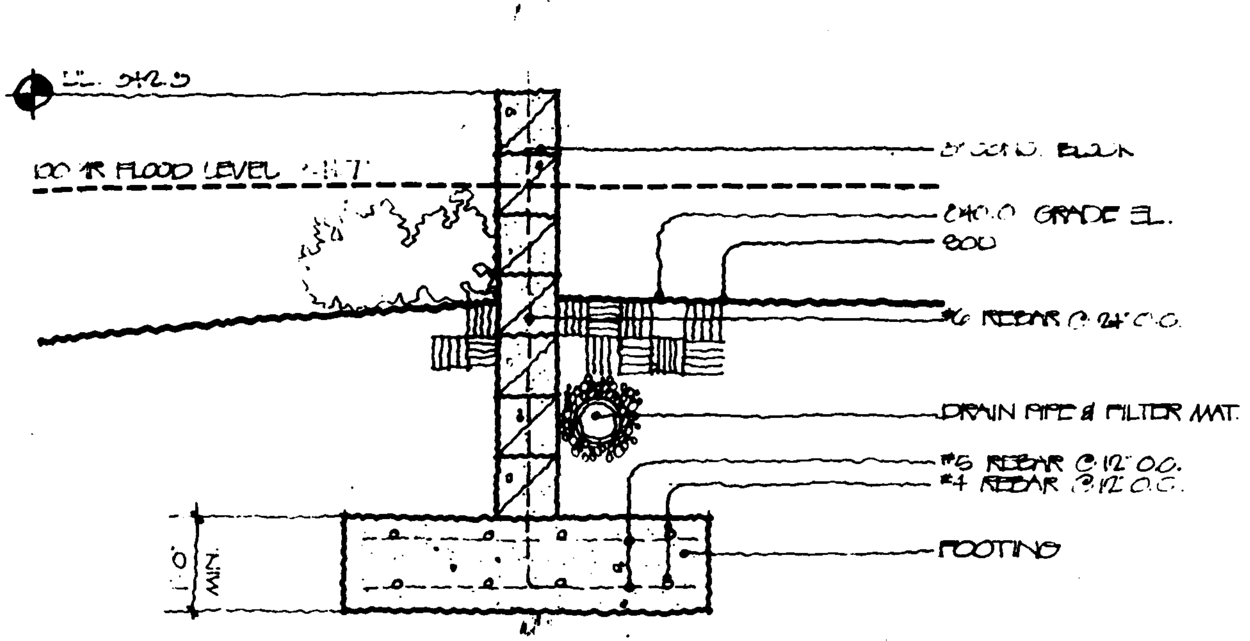
BASSETT CREEK DRIVE
RETAINING WALL TO ALLOW FOR LARGE EXISTING TREE
NEW RETAINING WALL
PROPOSED SITE PLAN
SCALE: 1"=20'
GUENTHER RESIDENCE/ 5005 BASSETT CREEK DRIVE
2

PLATE H-63



SECTION
SCALE: 1/8"=1'-0"
GUENTHER RESIDENCE / 5005 BASSETT CREEK DRIVE

3



WALL SECTION
SCALE: 3/4" = 1'-0"
GUENTHER RESIDENCE / 5005 BASSETT CRK. DRIVE

4

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE JACOBSON RESIDENCE LOCATED AT 5126 MINNAQUA AVENUE, THE WILLETS RESIDENCE LOCATED AT 5120 MINNAQUA AVENUE, AND THE PATKA RESIDENCE LOCATED AT 5110 MINNAQUA AVENUE, GOLDEN VALLEY, MINNESOTA: THE EXISTING ONE HUNDRED YEAR FLOOD LEVEL IS 847.5. THE PROPOSED ONE HUNDRED YEAR FLOOD LEVEL IS 842.9. THE PROPOSED LOW OPENINGS ARE 841.98, 841.69, AND 842.01, RESPECTIVELY. WE MUST FLOOD-PROOF TO A LEVEL OF 843.9.

THE SOIL CONDITIONS ARE SUITABLE FOR THE CONSTRUCTION OF A BERM, AND THERE IS HIGH GROUND ADJACENT TO THE STRUCTURES. A BERM COULD BE TIED INTO THIS HIGH GROUND. THE DISTANCES TO THE CREEK IN THE REAR YARDS ARE ALSO COMPATIBLE WITH THE CONSTRUCTION OF A BERM.

WE PROPOSED THAT A BERM BE CONSTRUCTED WHICH WOULD BEGIN AT THE PROPERTY LINE TO THE WEST OF THE JACOBSON RESIDENCE, AND END OF THE PROPERTY LINE TO THE EAST OF MR. PATKA'S PROPERTY, AS INDICATED ON THE SITE PLAN. WE WILL PROVIDE ONE SUMP PUMP PIT TO BE LOCATED IN THE NORTHWEST CORNER OF THE JACOBSON PROPERTY FOR ALL THREE YARDS. THE SIZE OF THE PIT WILL BE 48 INCHES IN DIAMETER. WE WILL REPLACE A LARGE TREE IN THE JACOBSON YARD, AND TWO OR THREE TREES ON BOTH WILLET'S AND PATKA'S PROPERTIES IF THEY ARE DESTROYED. THE YARD WILL BE REGRADED AND SODDED.

SEE PLATES H-66 AND H-67.

SUMMARY OF ELEVATIONS
5126 MINNAQUA AVENUE

DOOR SILL	841.98
TOP DECK	850.06
EXISTING 100 YEAR FLOOD LEVEL	847.5
PROPOSED 100 YEAR FLOOD LEVEL	842.9

SUMMARY OF ELEVATIONS
5120 MINNAQUA AVENUE

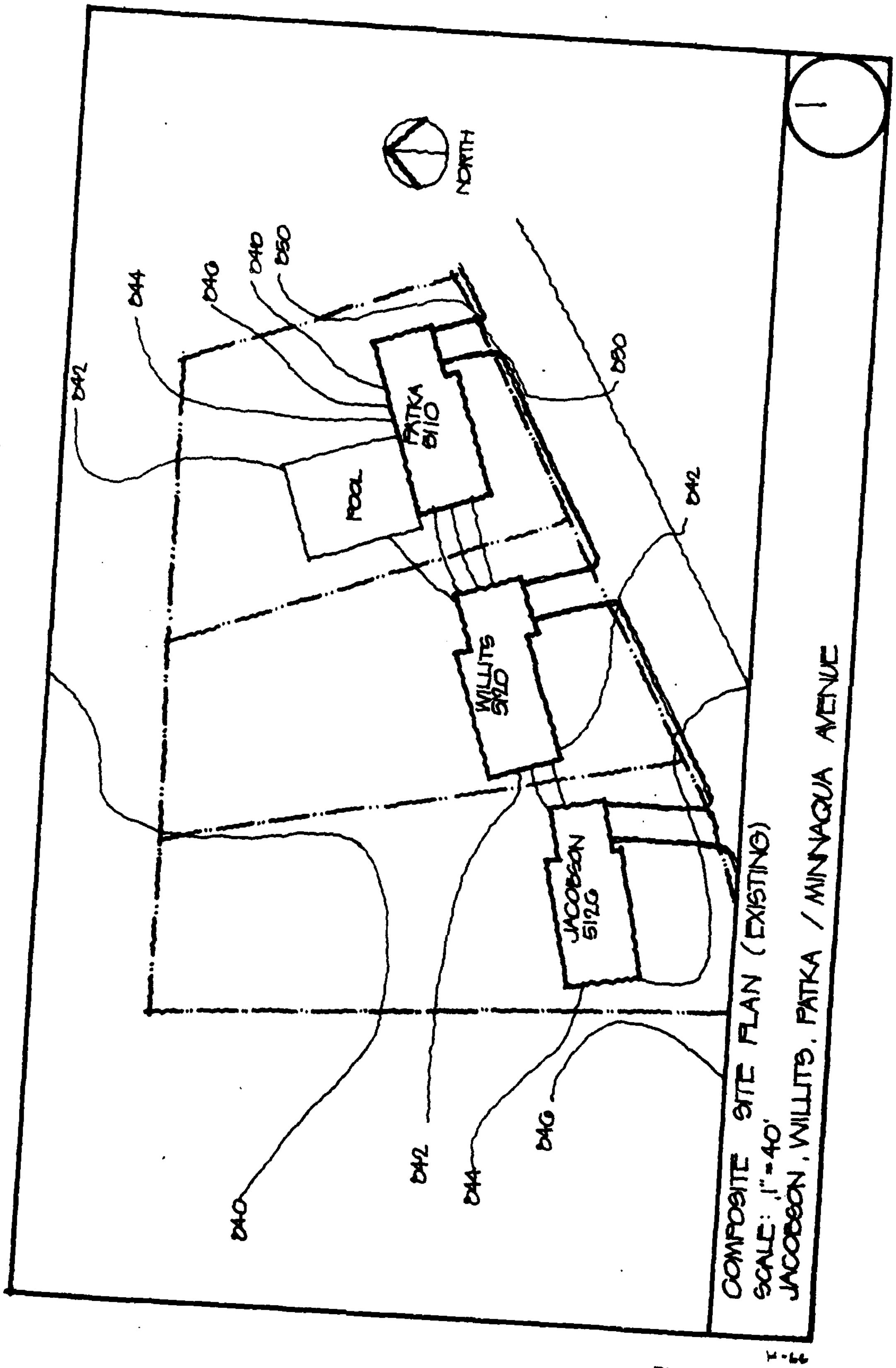
DOOR SILL	841.69
WINDOR SILL	843.93
FIRST FLOOR	849.9
EXISTING 100 YEAR FLOOD LEVEL	847.5
PROPOSED 100 YEAR FLOOD LEVEL	842.9

SUMMARY OF ELEVATIONS
5110 MINNAQUA AVENUE

DOOR SILL	842.01
WINDOW SILL	844.22
FIRST FLOOR	850.0
EXISTING 100 YEAR FLOOD LEVEL	847.5
PROPOSED 100 YEAR FLOOD LEVEL	842.9

CONSTRUCTION ESTIMATE:
5126, 5120, AND 5110 MINNAQUA AVENUE, GOLDEN VALLEY, MINNESOTA

EARTH WORK	
COMMON BORROW	$ 8,475.00
SOD WITH TOPSOIL	6,200.00
SEEDING WITH TOPSOIL	700.00
INTERIOR DRAINAGE	6,750.00
TOTAL ESTIMATE	$22,125.00
OR	$ 7,375.00/HOME



COMPOSITE SITE PLAN (EXISTING)
SCALE: 1"=40'
JACOBSON, WILLITS, PATKA / MINNAQUA AVENUE

H-66

PLATE H-66

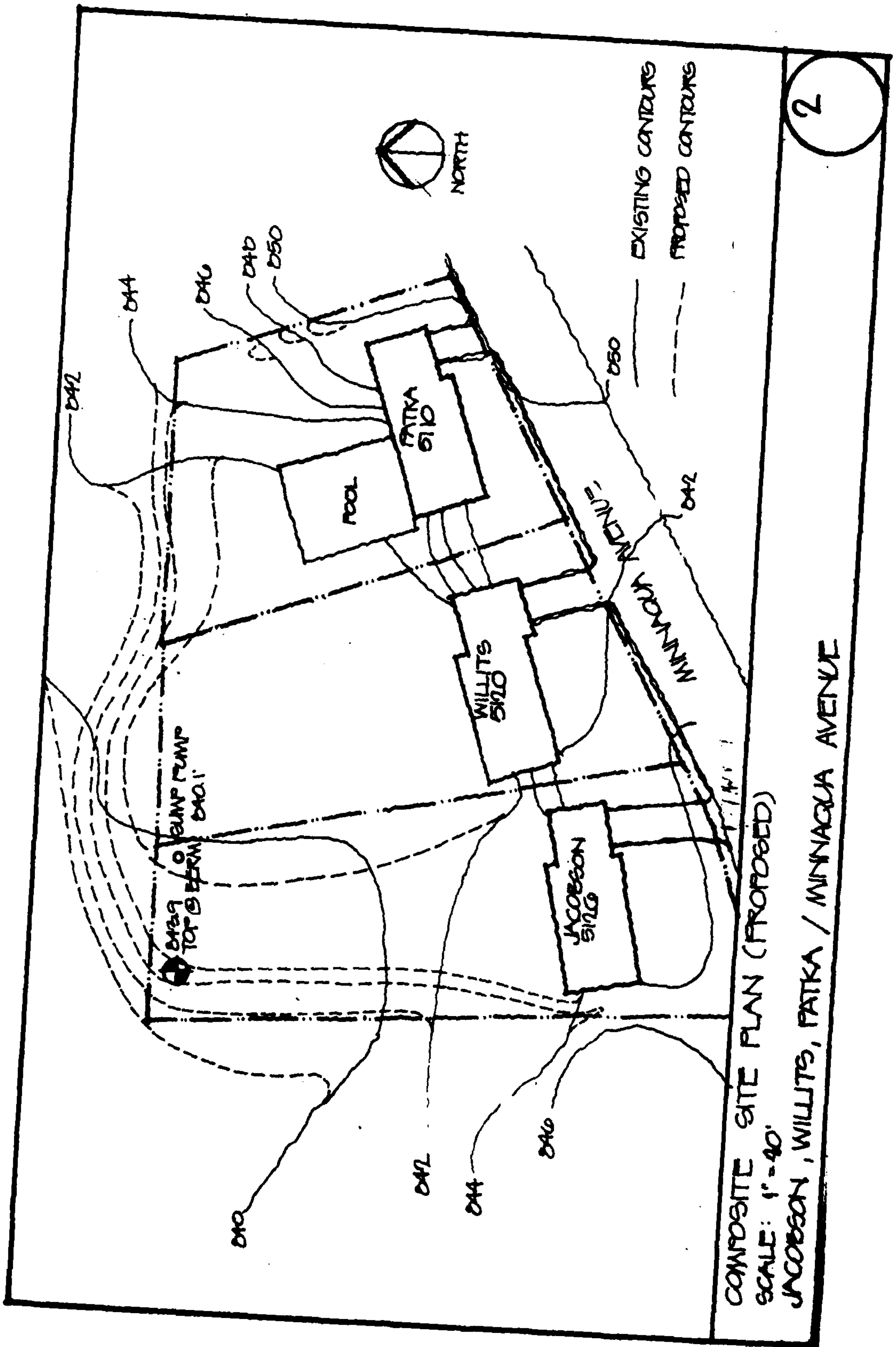

2
NORTH
EXISTING CONTOURS
PROPOSED CONTOURS
PATKA 5110
POOL
WILLITS 5120
JACOBSON 5126
MINNAQUA AVENUE
SUMP PUMP
TOP OF BERM
COMPOSITE SITE PLAN (PROPOSED)
SCALE: 1"=40'
JACOBSON, WILLITS, PATKA / MINNAQUA AVENUE

PLATE H-67

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE HEDBERG RESIDENCE LOCATED AT 5125 MINNAOUA AVENUE, GOLDEN VALLEY, MINNESOTA: THE EXISTING ONE HUNDRED YEAR FLOOD LEVEL IS 847.4. THE PROPOSED ONE HUNDRED YEAR FLOOD LEVEL IS 842.9. THE LOW OPENING IN THE RESIDENCE IS 841.41, WHICH IS A DOOR OPENING.

THE SOILS AROUND THE REAR OF THE HOME ARE SUITABLE FOR THE CONSTRUCTION OF A BERM. THE GRADE ON BOTH SIDES OF THE RESIDENCE IS HIGH AND SUITABLE TO BERM AGAINST. THE REAR YARD IS FAR ENOUGH FROM THE CREEK TO ALLOW BERMING. THE INTERIOR OF THE HOME IS COMPLETELY FINISHED.

WE RECOMMEND FLOOD-PROOFING THE HOME BY MEANS OF A BERM AROUND THE RESIDENCE. WE WILL CONSTRUCT THE BERM AS INDICATED ON THE PROPOSED SITE PLAN WHICH ACCOMPANIES THIS SUBMITTAL. WE WILL GRADE THE SITE TO ALLOW FOR THE STORAGE OF A TEN YEAR FREQUENCY RAIN FALL WITHOUT THE OCCURRENCE OF FLOOD DAMAGE IN THE EVENT OF A PUMP FAILURE (MECHANICAL OR ELECTRICAL). WE WILL PROVIDE A SUMP PUMP PIT INSIDE THE BERM TO REMOVE THE INTERIOR DRAINAGE WITH ADEQUATE CAPACITY FOR THE CRITICAL 100-YEAR FREQUENCY STORM.

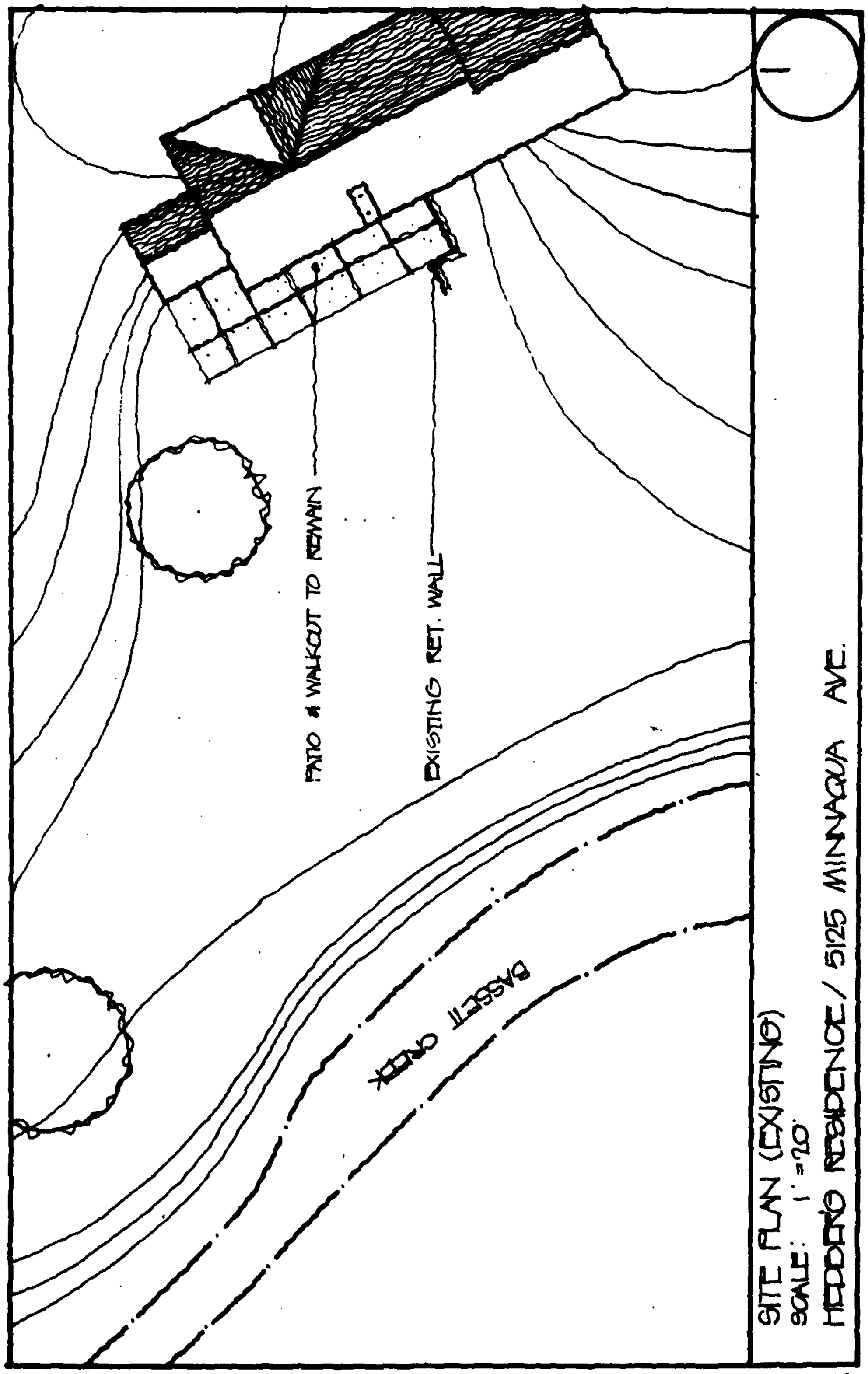
SEE PLATES H-68 THROUGH H-70.

SUMMARY OF ELEVATIONS

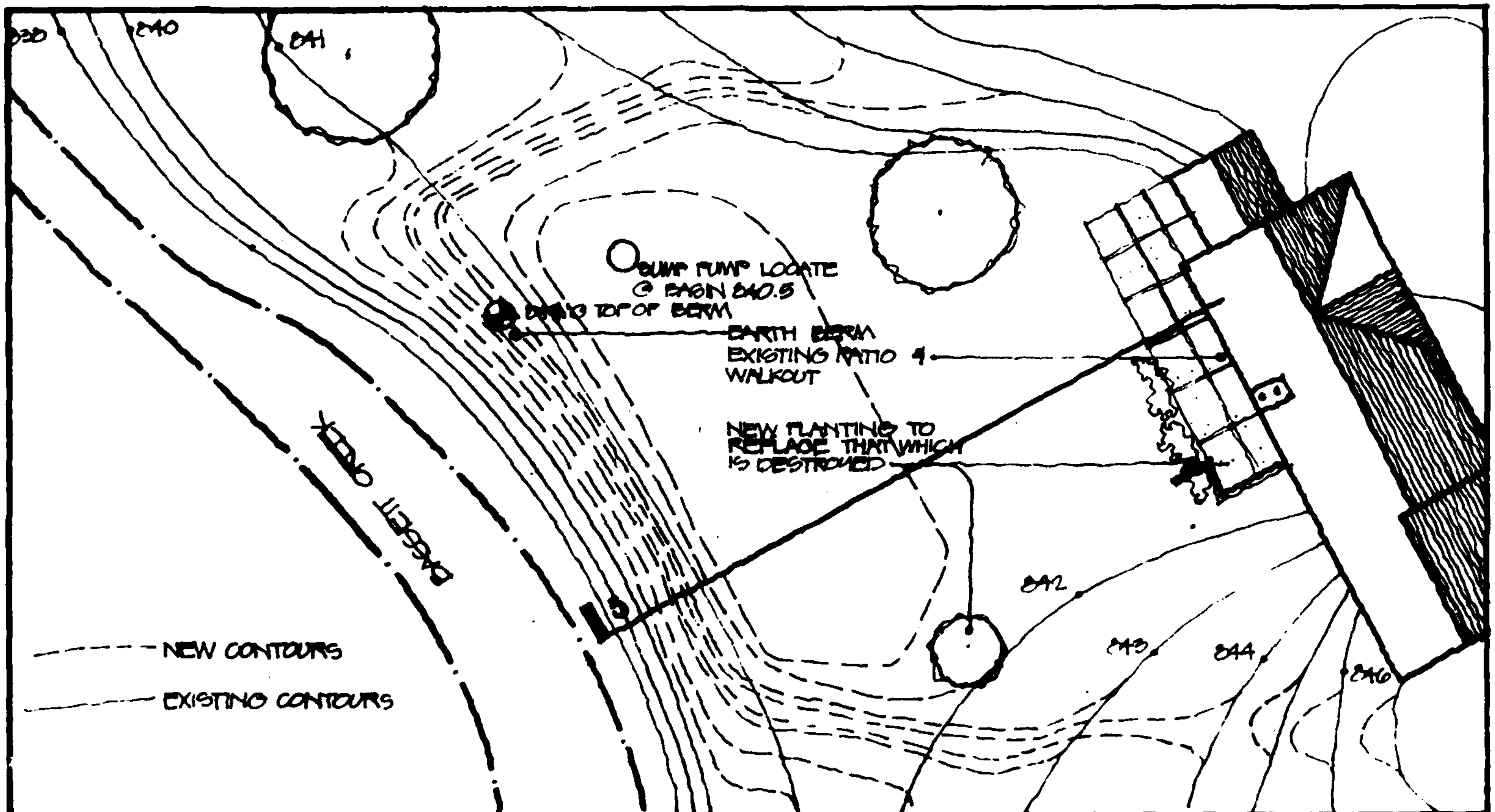
DOOR SILL	841.53
WINDOW SILL	844.03
WINDOW SILL	847.11
FIRST FLOOR	850.24
WINDOW SILL	842.68
DOOR SILL	841.41

CONSTRUCTION ESTIMATE
5125 MINNAOUA AVENUE, GOLDEN VALLEY, MINNESOTA

EARTHWORK	
COMMON BORROW	$ 550.00
COMMON EXCAVATION	75.00
SOD WITH TOPSOIL	4,300.00
INTERIOR DRAINAGE	6,050.00
TOTAL ESTIMATE	$ 10,925.00



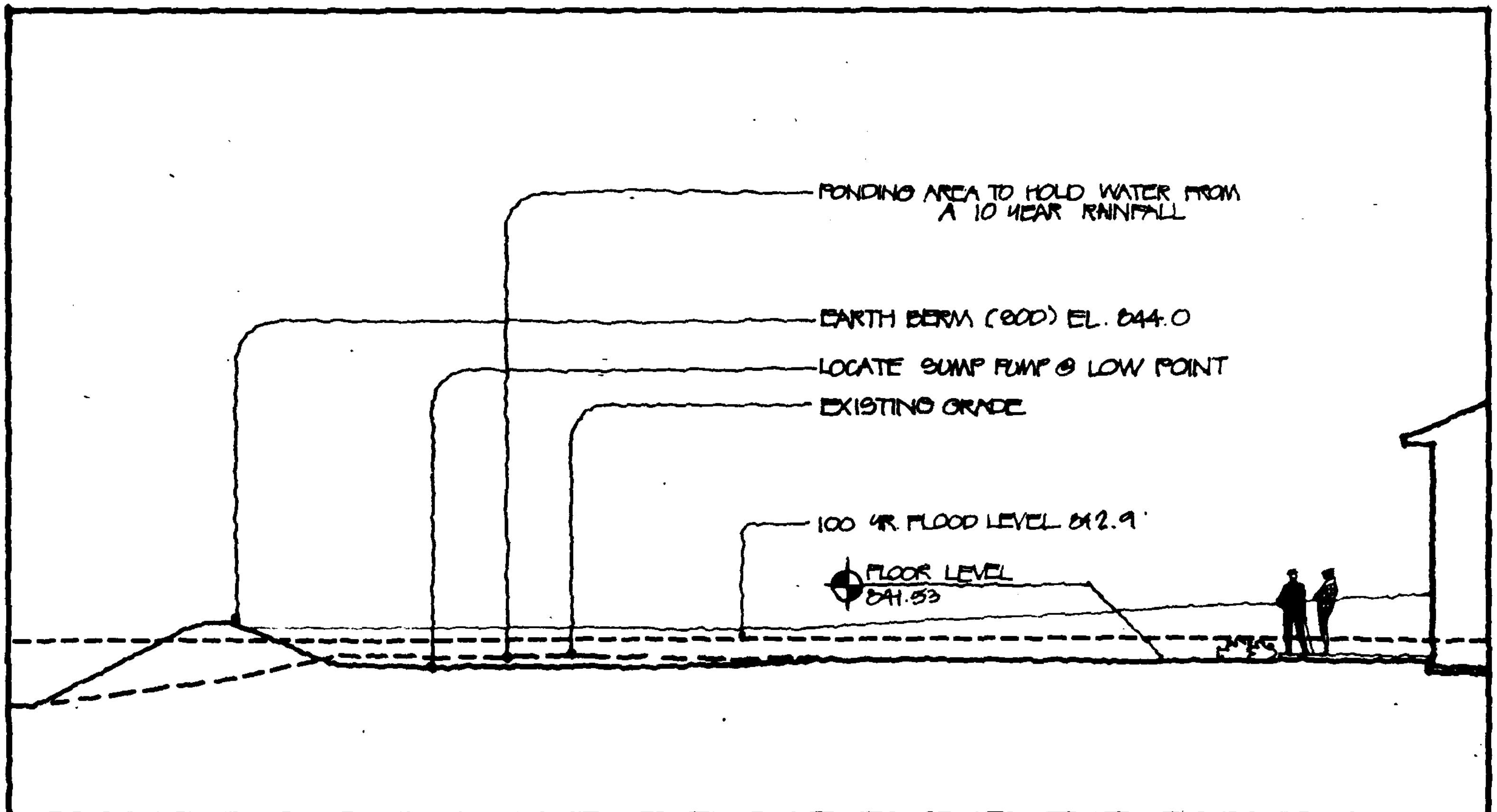
H-68
PLATE H-68



SITE PLAN (PROPOSED)
SCALE: 1" = 20'
HEDBERG RESIDENCE / 5125 MINNAQUA AVE.

2

PLATE H-89



SITE SECTION
SCALE: 1/8" = 1'-0"
HEDBERG RESIDENCE/ 5125 MINNAQUA AVE.

5

PLATE H-70 Plate H-17.

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE HANSEN RESIDENCE LOCATED AT 5222 MINNAQUA AVENUE, GOLDEN VALLEY, MINNESOTA: THE LOW OPENING OF THIS HOME IS 841.40. THE ONE HUNDRED YEAR FLOOD LEVEL IS 842.9. WE MUST FLOOD-PROOF TO A LEVEL OF 843.9.

THE HOME IS BUILT ON AN EXISTING SANDBAR WITH PEAT SURROUNDING THE HOUSE. ONE OR TWO INCHES OF FLOOD WATER PENTRATED THE HOME IN THE 1978 FLOOD. THEREFORE, DUE TO THE SOIL CONDITIONS AND THE COMPLEXITY OF THE STRUCTURE ITSELT, WE FEEL THE BEST SOLUTION IS AN EARTH BERM. THE BERM WOULD VIRTUALLY SURROUND THE ENTIRE HOME AND TIE INTO THE EXISTING CONTOURS AT THE REAR OF THE RESIDENCE. AN INTERIOR DRAINAGE SYSTEM WITH SUMP PUMP WOULD ALSO BE INSTALLED.

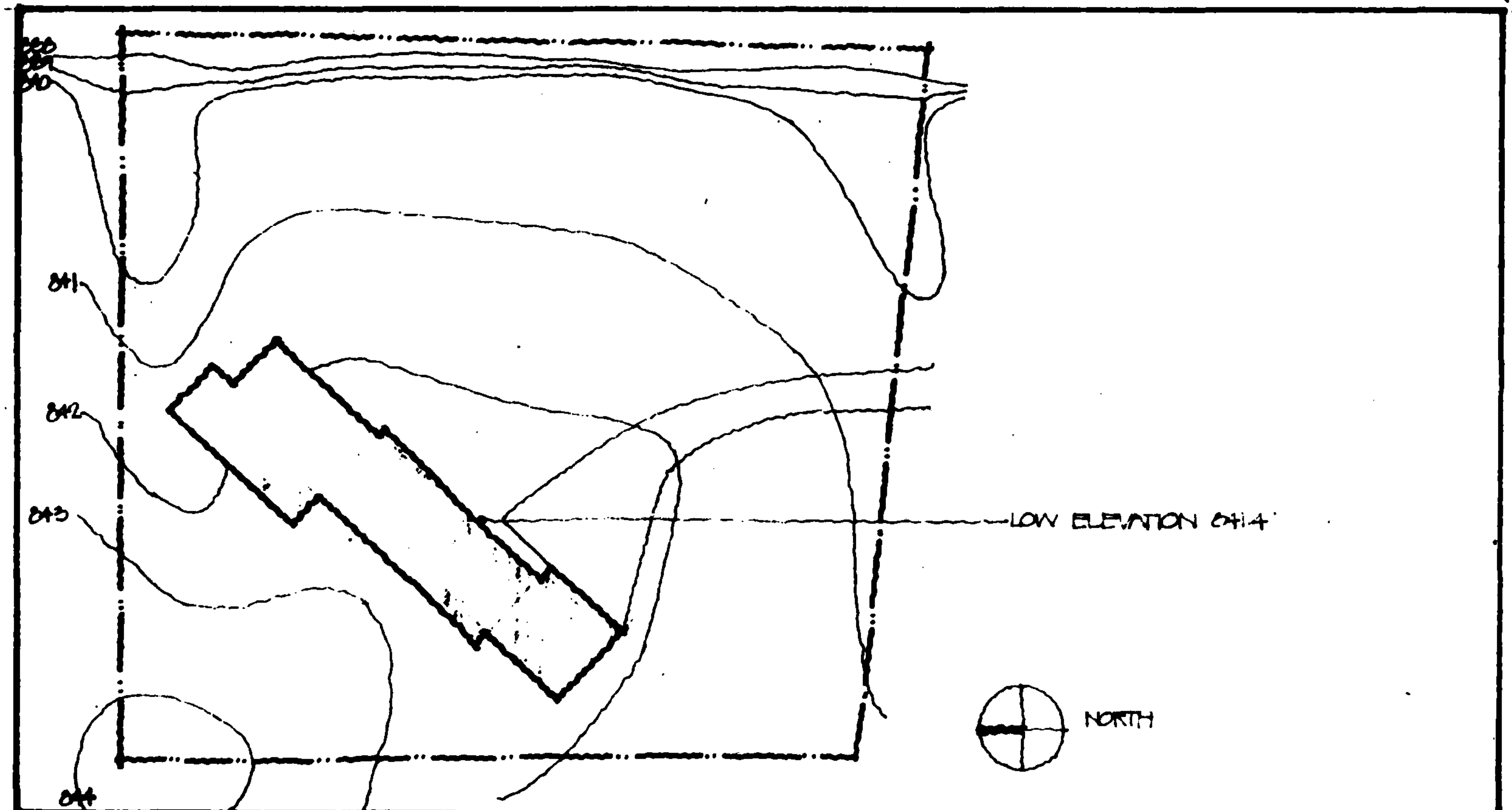
SEE PLATES H-71 AND H-72.

SUMMARY OF ELEVATIONS

DOOR SILL	841.40
DOOR SILL	841.40
WINDOW SILL	843.40
100-YEAR FLOOD LEVEL	842.9
FLOOD PROOF LEVEL	843.9

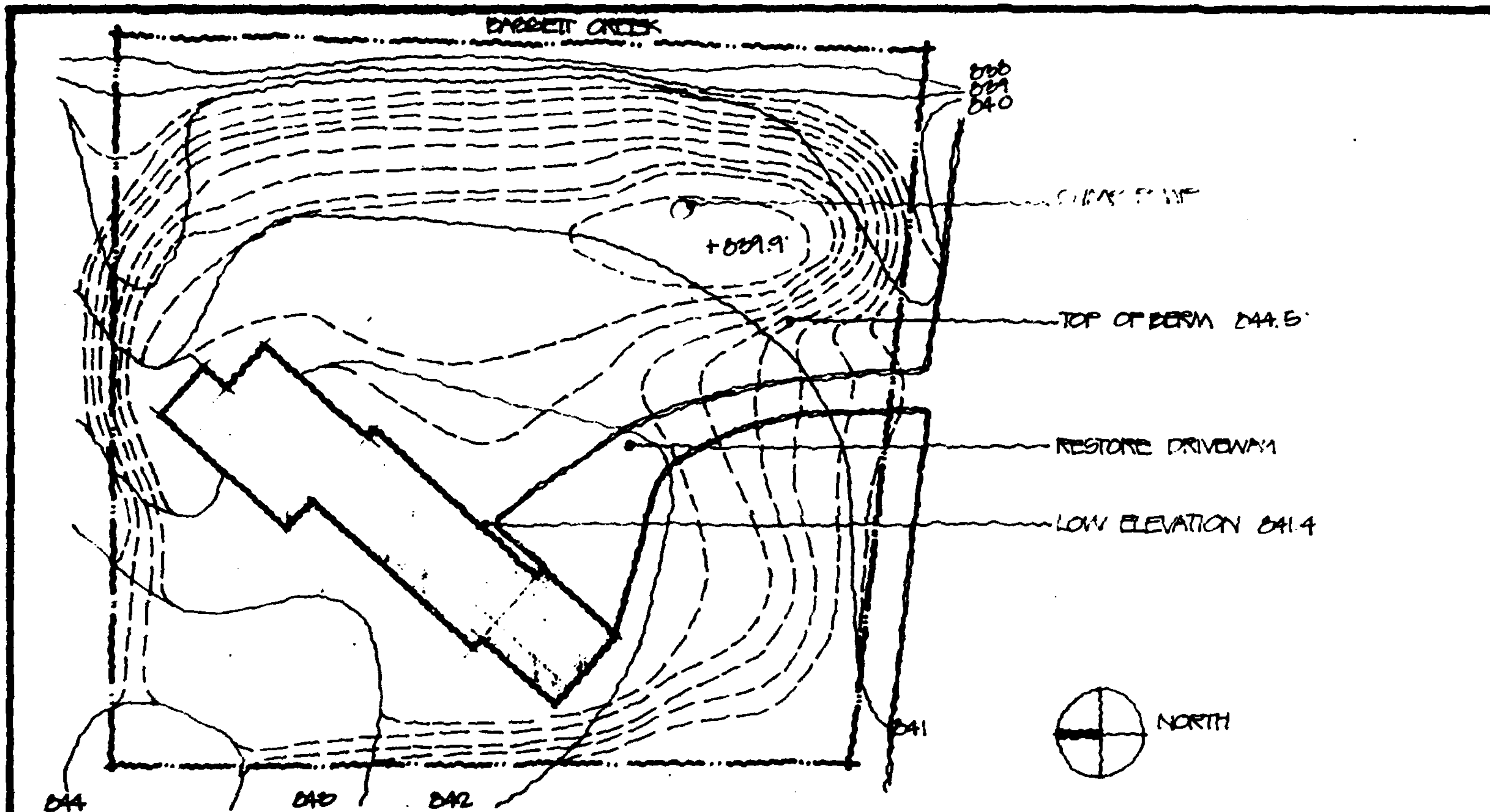
CONSTRUCTION ESTIMATE
5222 MINNAQUA AVENUE, GOLDEN VALLEY, MINNESOTA

EARTHWORK	
COMMON BORROW	$12,575.00
SOD WITH TOPSOIL	425.00
SEEDING WITH TOPSOIL	9,350.00
INTERIOR DRAINAGE	6,050.00
DRIVEWAY	3,850.00
TOTAL ESTIMATE	$34,500.00



EXISTING SITE PLAN
SCALE: 1"=40'
HANSEN RESIDENCE / 5222 MINNAQUA AVE.

PLATE H-7



PROPOSED SITE PLAN
SCALE: 1"=40'
HANSEN RESIDENCE / 5222 MINNAQUA AVE.

2

PLATE A-72

BASSETT CREEK FLOOD-PROOFING
SPECIFIC RECOMMENDATIONS

THE HICKS RESIDENCE LOCATED AT 5130 MINNAQUA AVENUE, GOLDEN VALLEY, MINNESOTA: THE ONE HUNDRED YEAR FLOOD LEVEL IS 842.0 AT THIS AREA WITH THE HICKS' LOWER LEVEL AT 840.38. THE HOME EXPERIENCES EXTREME FLOODING DURING ALL MAJOR RAIN STORMS. THE FURNISHINGS IN THE HOME ARE ALL PORTABLE (INCLUDING THE CARPETING) SO THAT THEY CAN BE CARRIED TO HIGHER GROUND IN THE EVENT OF AN IMPENDING RAIN STORM. THE PROBLEM IS FURTHER COMPLICATED BY THE CLOSE PROXIMITY OF THE CREEK TO THE HOME ON TWO SIDES. CONSEQUENTLY, THE ONLY SOLUTION SHORT OF RAISING THE STRUCTURE IS TO BERM AGAINST THE REAR OF THE HOME AND CLOSE UP THE WALK-OUT. THE USE OF A PATIO ON THAT LEVEL WOULD BE LOST, THEREFORE, IT IS RECOMMENDED THAT A REDWOOD DECK BE CONSTRUCTED TO REPLACE THE PATIO WHICH WOULD BE LOST. WE WILL ALSO PROVIDE DRAIN TILE AROUND THE REAR AND SIDES OF THE HOME AND INCORPORATE A SUMP PUMP PIT WITHIN THE DRAIN TILE SYSTEM.

SEE PLATES H-73 THROUGH H-78.

SUMMARY OF ELEVATIONS:

MAIN LEVEL	847.55
WINDOW SILLS	842.46
LOWER LEVEL	840.38
100 YEAR FLOOD LEVEL	842.0
NEW WINDOW WELL LEVEL	843.02
FLOOD PROTECTION ELEVATION	843.0

CONSTRUCTION ESTIMATE
5130 MINNAQUA AVENUE, GOLDEN VALLEY, MINNESOTA

CARPENTRY	
LABOR & MATERIALS	$ 1,350.00
DECK (LABOR & MATERIALS)	1,350.00
MASONRY	
WALL	275.00
SUMP PUMP PIT	5,375.00
DRAIN TILE (130 LINEAL FT)	3,350.00
ELECTRICAL (MISC.)	275.00
TOTAL ESTIMATE:	$11,975.00

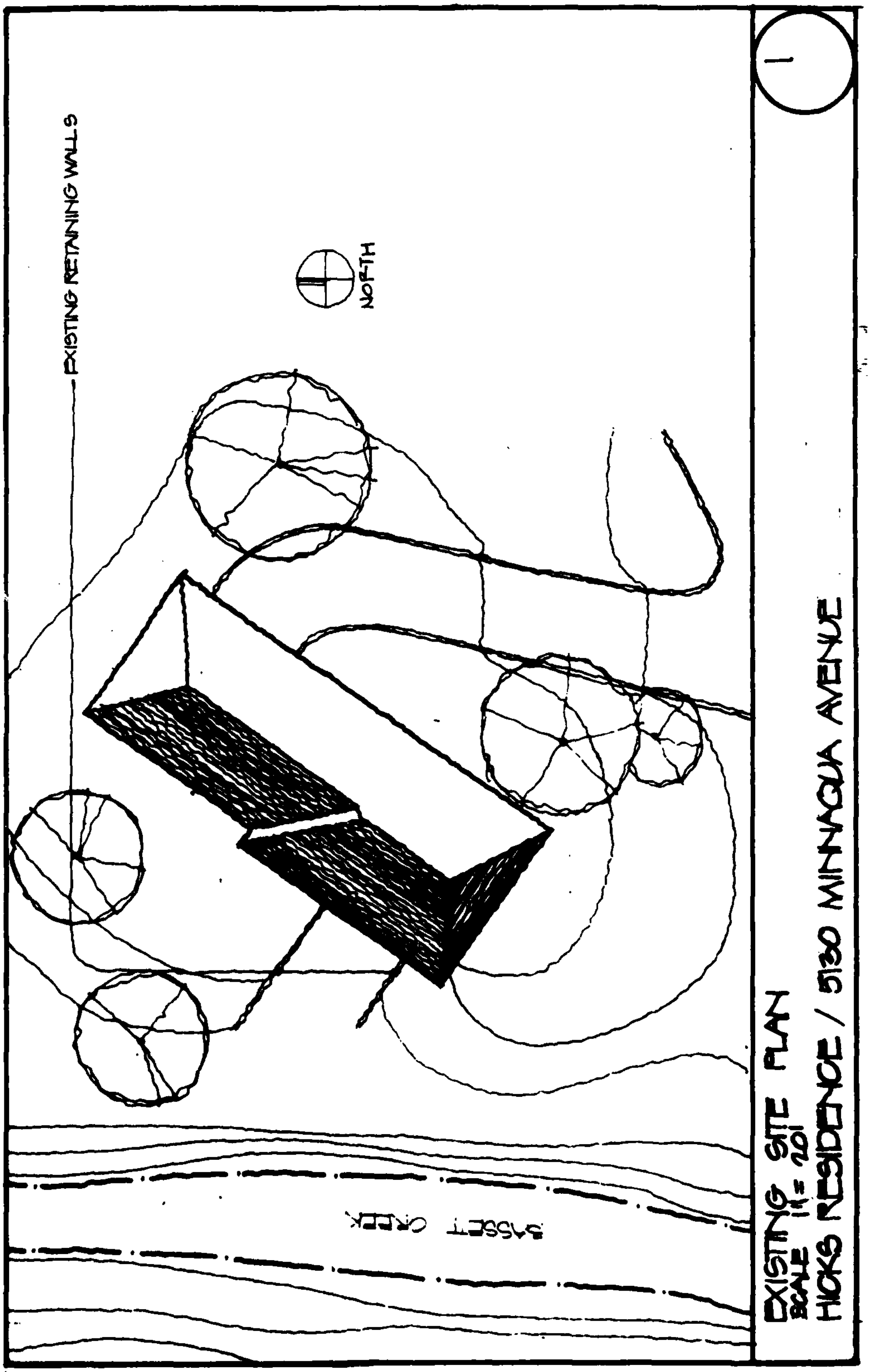


PLATE H-73. 4-73

AD-A133 795 BASSETT CREEK WATERSHED HENNEPIN COUNTY MINNESOTA FEASIBILITY REPORT FOR FLOOD CONTROL MAIN REPORT(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 82 7/7

UNCLASSIFIED F/G 13/2 NL

END
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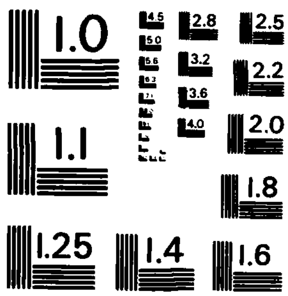
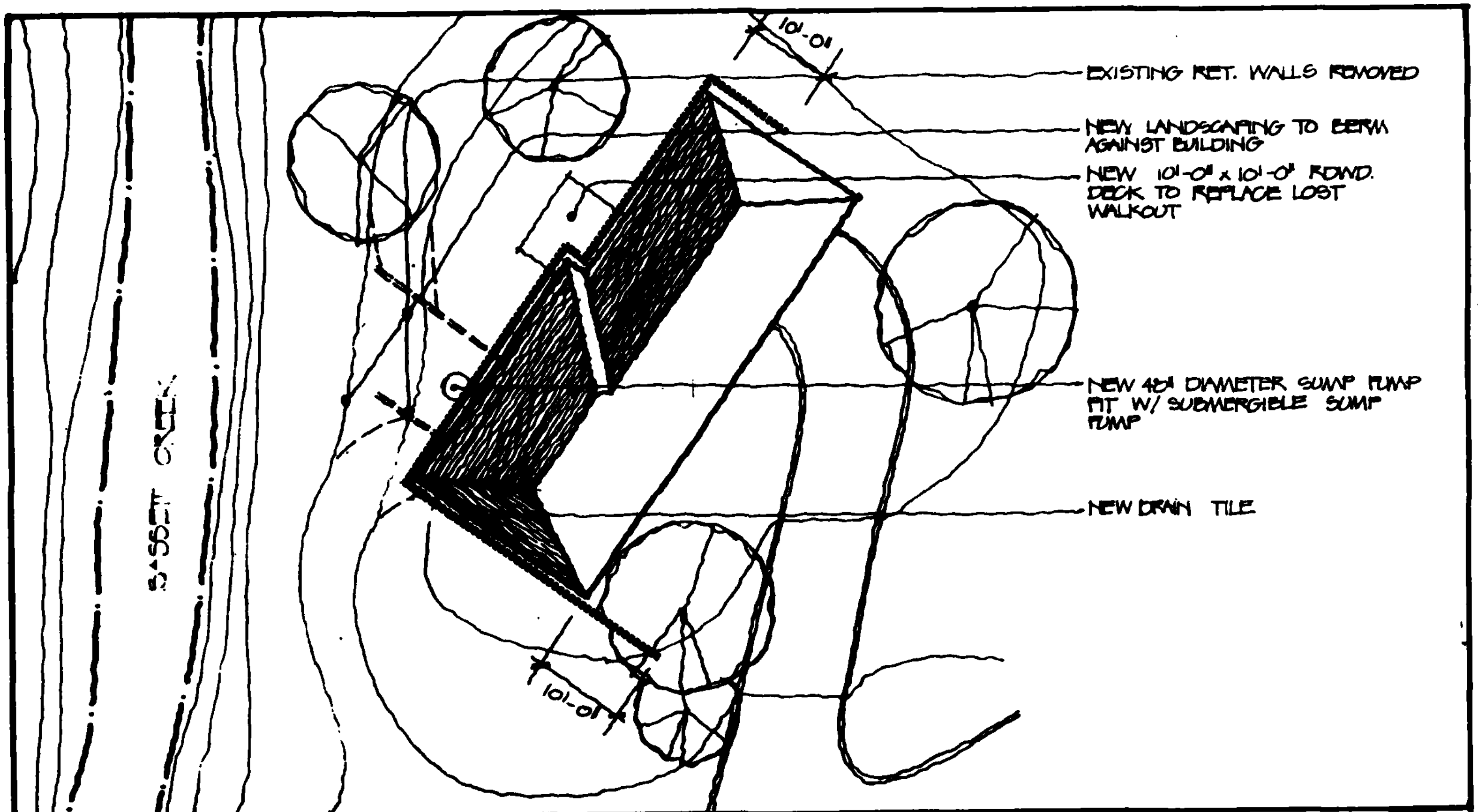
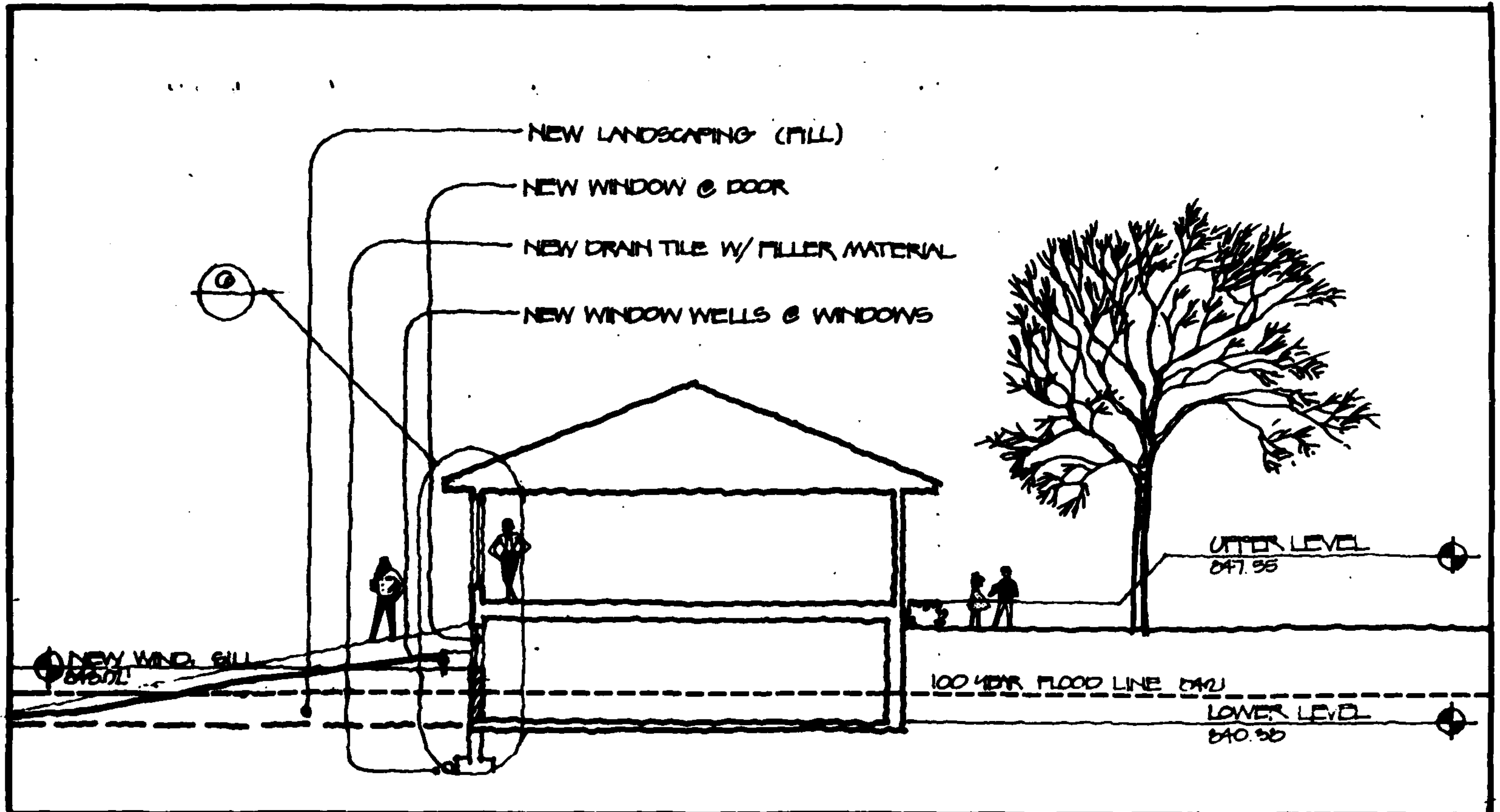

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6



PROPOSED SITE PLAN
SCALE 1" = 20'
HICKS RESIDENCE / 5130 MINNAQUA AVENUE

2

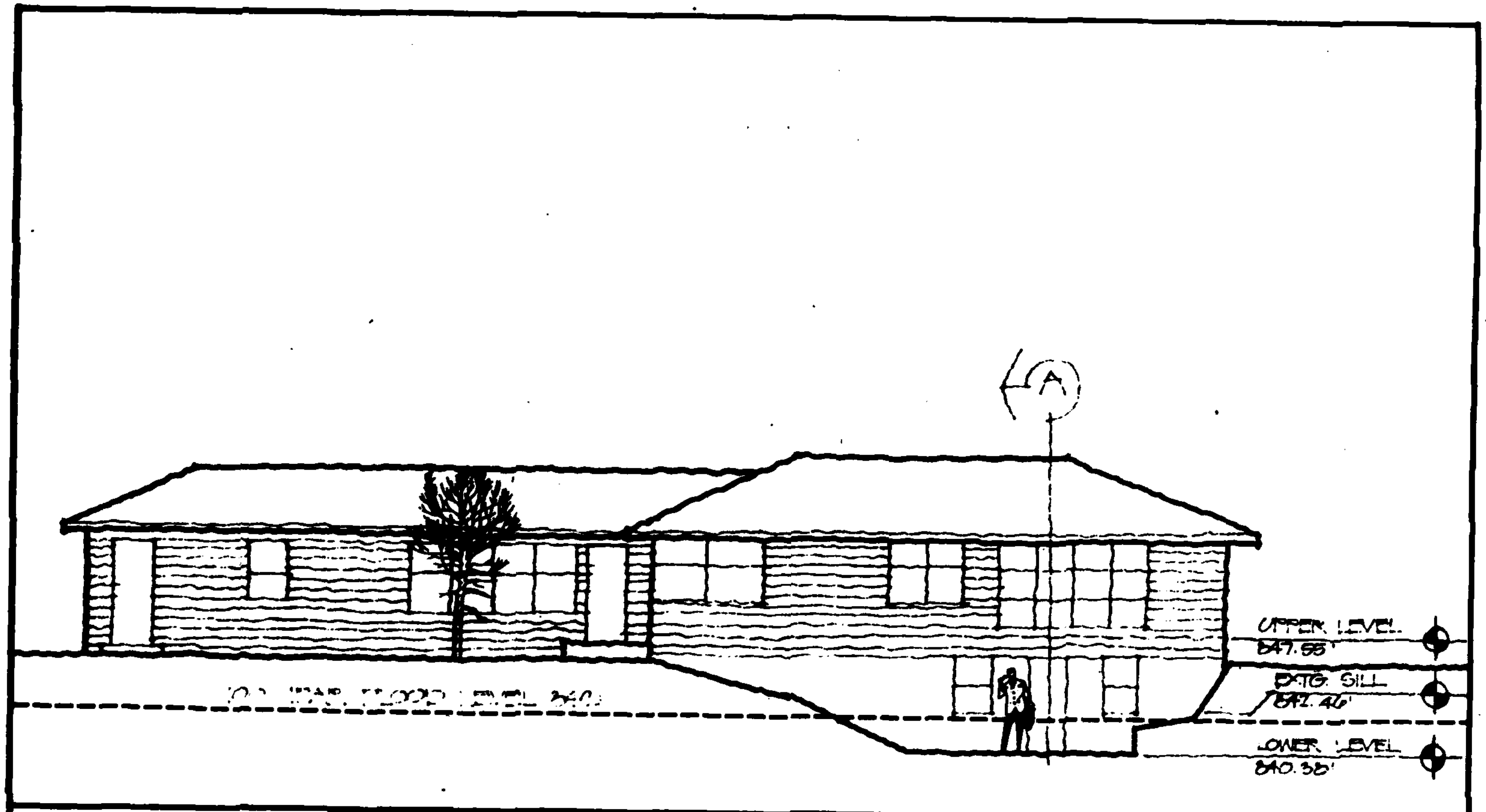
PLATE H-74



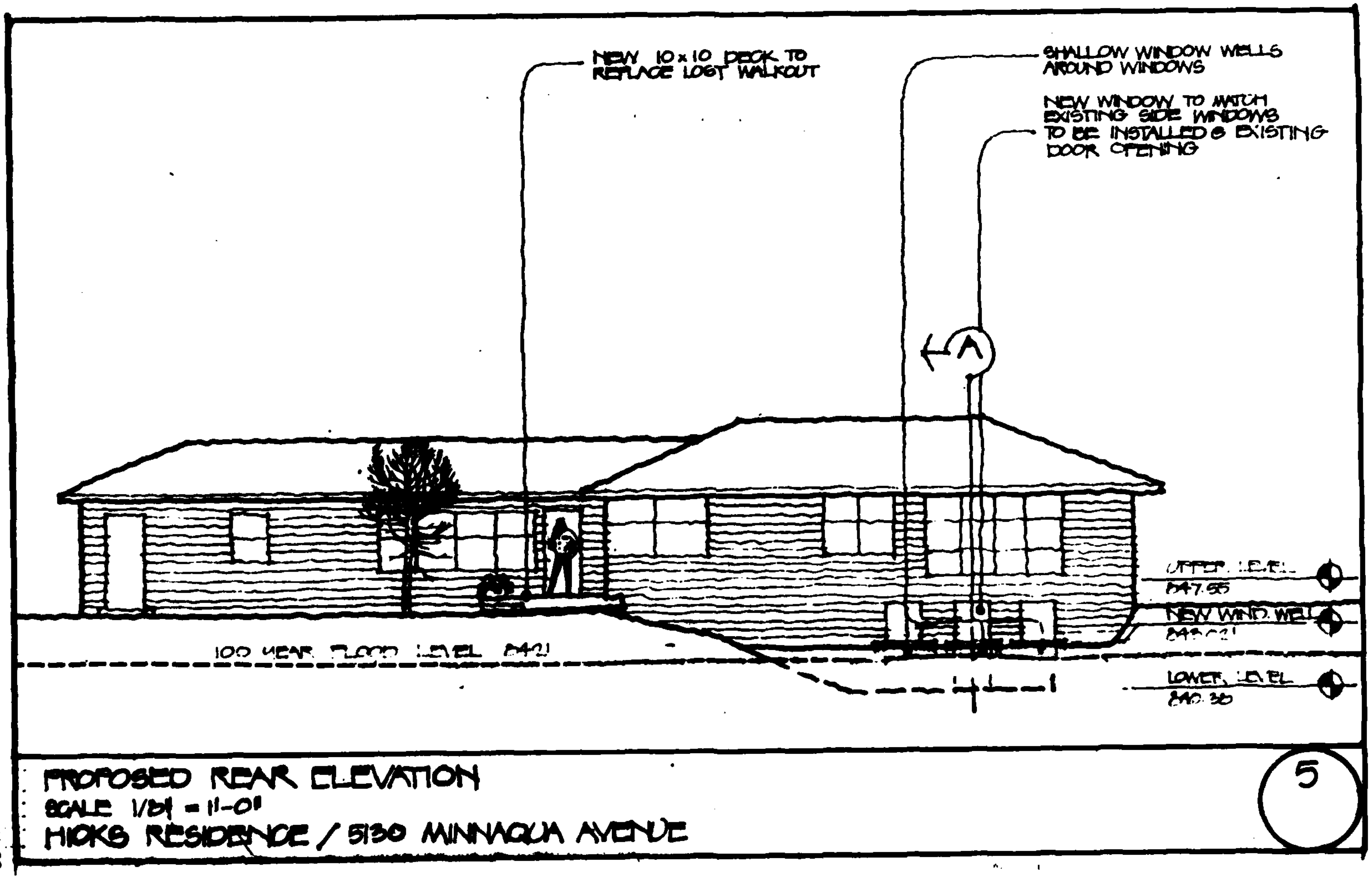
BUILDING SECTION
SCALE : 1/8" = 1'-0"
HICKS RESIDENCE/ 5130 MINNAQUA AVENUE

3

PLATE H-75

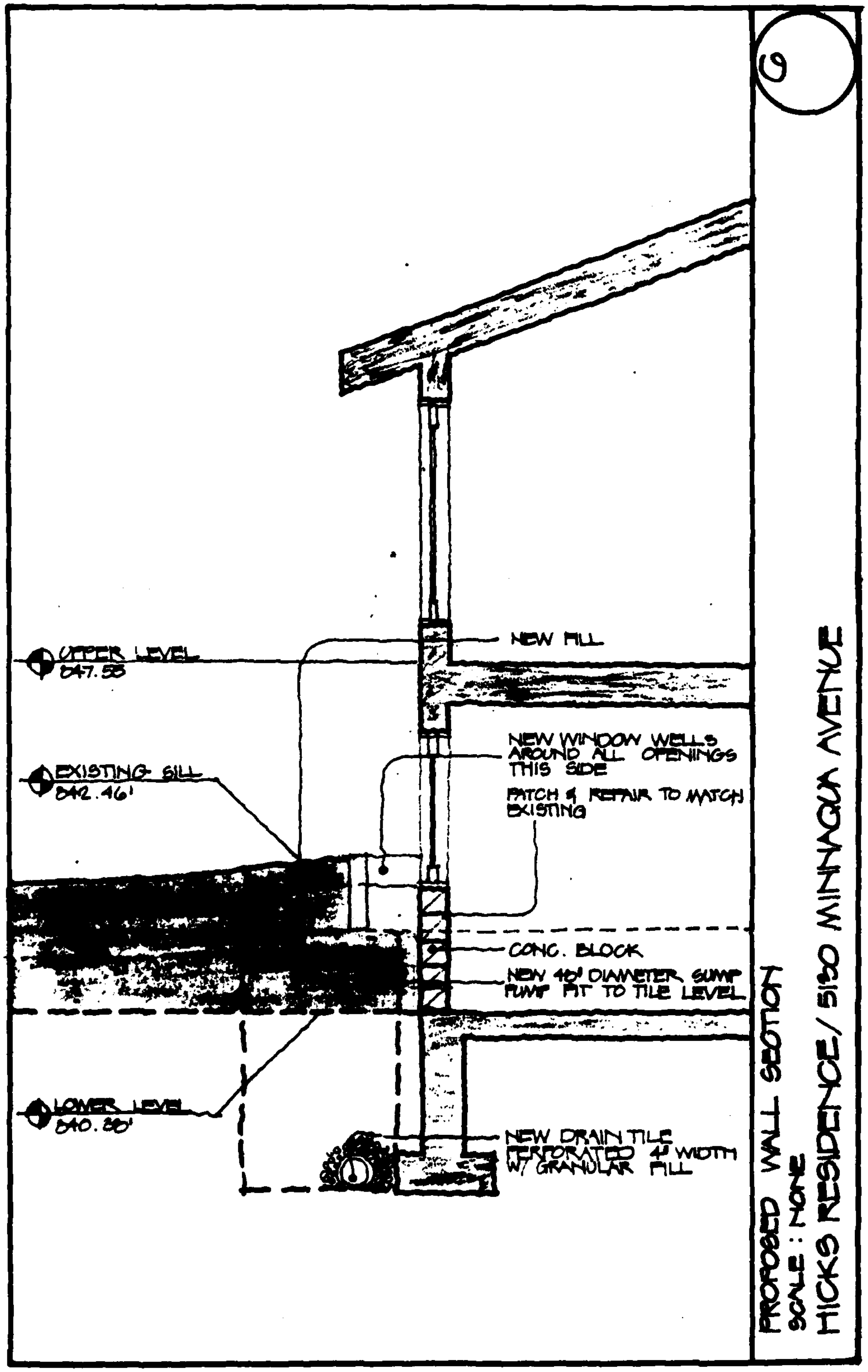


EXISTING REAR ELEVATION
SCALE 1/8" = 1'-0"
HICKS RESIDENCE / 5130 MINNAQUA AVENUE



H-77

PLATE H-77



UPPER LEVEL
847.58
EXISTING SILL
842.46'
LOWER LEVEL
840.88'
NEW FILL
NEW WINDOW WELLS AROUND ALL OPENINGS THIS SIDE
PATCH & REPAIR TO MATCH EXISTING
CONC. BLOCK
NEW 48" DIAMETER SUMP PUMP PIT TO TILE LEVEL
NEW DRAIN TILE PERFORATED 4" WIDTH W/ GRANULAR FILL
PROPOSED WALL SECTION
SCALE: NONE
HICKS RESIDENCE/ 5130 MINNAQUA AVENUE

PLATE H-78

FLOOD PROOFING COST SUMMARY

ADDRESS	COST	
2605 SCOTT AVENUE NORTH	$43,400	RAISES
2655 SCOTT AVENUE NORTH	41,500	
2665 SCOTT AVENUE NORTH	46,800	
2675 SCOTT AVENUE NORTH	44,200	
2685 SCOTT AVENUE NORTH	7,383	1 GROUP
2725 SCOTT AVENUE NORTH	7,383	$22,150
2735 SCOTT AVENUE NORTH	7,383	
2755 SCOTT AVENUE NORTH	5,550	1 GROUP
2775 SCOTT AVENUE NORTH	5,550	$11,100
1205 IDAHO AVENUE NORTH	11,675	
2425 REGENT AVENUE NORTH	7,375	1 GROUP
2445 REGENT AVENUE NORTH	7,375	$14,750
2505 REGENT AVENUE NORTH	10,925	1 GROUP
2545 REGENT AVENUE NORTH	10,925	$21,850
3810 BASSETT CREEK DRIVE	16,450	1 GROUP
3820 BASSETT CREEK DRIVE	16,450	$32,900
4975 BASSETT CREEK DRIVE	14,125	
5005 BASSETT CREEK DRIVE	14,625	
5110 MINNAQUA DRIVE	7,375	1 GROUP
5120 MINNAQUA DRIVE	7,375	$22,125
5126 MINNAQUA DRIVE	7,375	
5125 MINNAQUA DRIVE	10,925	
5222 MINNAQUA DRIVE	34,500	
5130 MINNAQUA AVENUE NORTH	11,975	
TOTAL	$398,600	

DEPARTMENT OF THE ARMY
St. Paul District Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

FLOOD CONTROL

BASSETT CREEK

HENNEPIN COUNTY, MINNESOTA

DESIGN MEMORANDUM NO. 2, PHASE II

APPENDIX I

SECTION 215 PROGRAM

Table of Contents

APPENDIX I

SECTION 215 PROGRAM

GENERAL

1. In August 1979, an agreement under Section 215, Public Law 90-483, was completed to allow advance construction on certain authorized project features by the project sponsors. The agreement between the city of Golden Valley, Minnesota and the Corps of Engineers was also cosigned by the city of Minneapolis, Minnesota. The advance construction was to include new channel crossings, the T.H. 100 embankment, the Edgewood embankment and storage area, the Wisconsin Avenue embankment, the evacuation of one home near 36th Avenue and Florida Avenue in Crystal, channel improvements downstream from T.H. 100 including removal of the Minnaqua Avenue bridge, and floodproofing of 20 residences on the main stem Bassett Creek between Golden Valley Road and T.H. 100 in the city of Golden Valley. In October 1981, a contract was awarded to Shafer Construction Company for construction of certain of the project features. Due to increasing costs, constraints on local funding, the developing federal design program and the identification of required federal design criteria, the Section 215 program was reduced to include only those features which could be constructed independently of other project features and result in significant early flood relief. Several features were totally eliminated and several others were modified or reduced in scale. Some of the latter items perform basically the same function as the designs developed by the District and included in this design memorandum, but do not meet established Corps design criteria. It is anticipated that the Shafer contract will be completed by November 1982. Details on the status of each of the original Section 215 features follow.

CROSSINGS

2. New channel crossings will be constructed at Noble Avenue, Regent Avenue, 32nd Avenue, Brunswick Avenue, 34th Avenue, Florida Avenue, and 36th Avenue. The Douglas Drive crossing was included in the 221 agreement as an advance construction item but was dropped due to high expense, the possibility of future Hennepin County improvements to Douglas Drive and relatively lower priority as a problem area. The two crossings at Noble Avenue and Regent Avenue were bid as alternate designs using a prefab arch-bridge concept. Bids on the alternate designs were attractive enough to have the contract awarded with the alternates. The alternate designs are considered hydraulic equivalents of designs presented on Plate 21. A drawing showing the alternate designs can be found on Plate I-3. Construction of the crossings are considered non-Federal cost items.

MINNAQUA AVENUE BRIDGE REMOVAL

3. As part of the advance construction program, the Minnaqua Avenue bridge and abutments will be removed and the immediate area will be relandscaped to match the surrounding grounds. A new cul-de-sac will be constructed as a terminus to Minnaqua Avenue on the east bank and a curb inlet will be installed for storm drainage. See Plate 22. The bridge and abutment removals, relandscaping and the storm pipe to the creek from the inlet manhole are considered Federal cost items. The cul-de-sac and storm inlet are considered part of a local improvement program and are non-Federal cost items.

WISCONSIN AVENUE EMBANKMENT

4. The Wisconsin Avenue embankment and control structure will not be constructed under the Shafer contract. Indecision on area development details required delaying completion of this item. Embankment fill materials and the control structure are considered Federal cost items. Excess fill required for the proposed roadway, surfacing and other roadway materials are considered non-Federal cost items. The city of Golden Valley may still decide to construct this feature in advance of Federal construction and within the time frame defined in the 215 agreement. A site farther upstream is presently being considered as a better location for this control structure.

TRUNK HIGHWAY 100 EMBANKMENT

5. Under the Shafer contract, a control structure will be attached to the existing box culverts which constitute the existing Bassett creek crossing of T.H. 100. This design cannot be used to complete the project design shown on Plates 23-27. Therefore, this advance work is considered an interim measure not Federally reimbursable. Upon Federal construction of the T.H. 100 embankment, the temporary control will be removed.

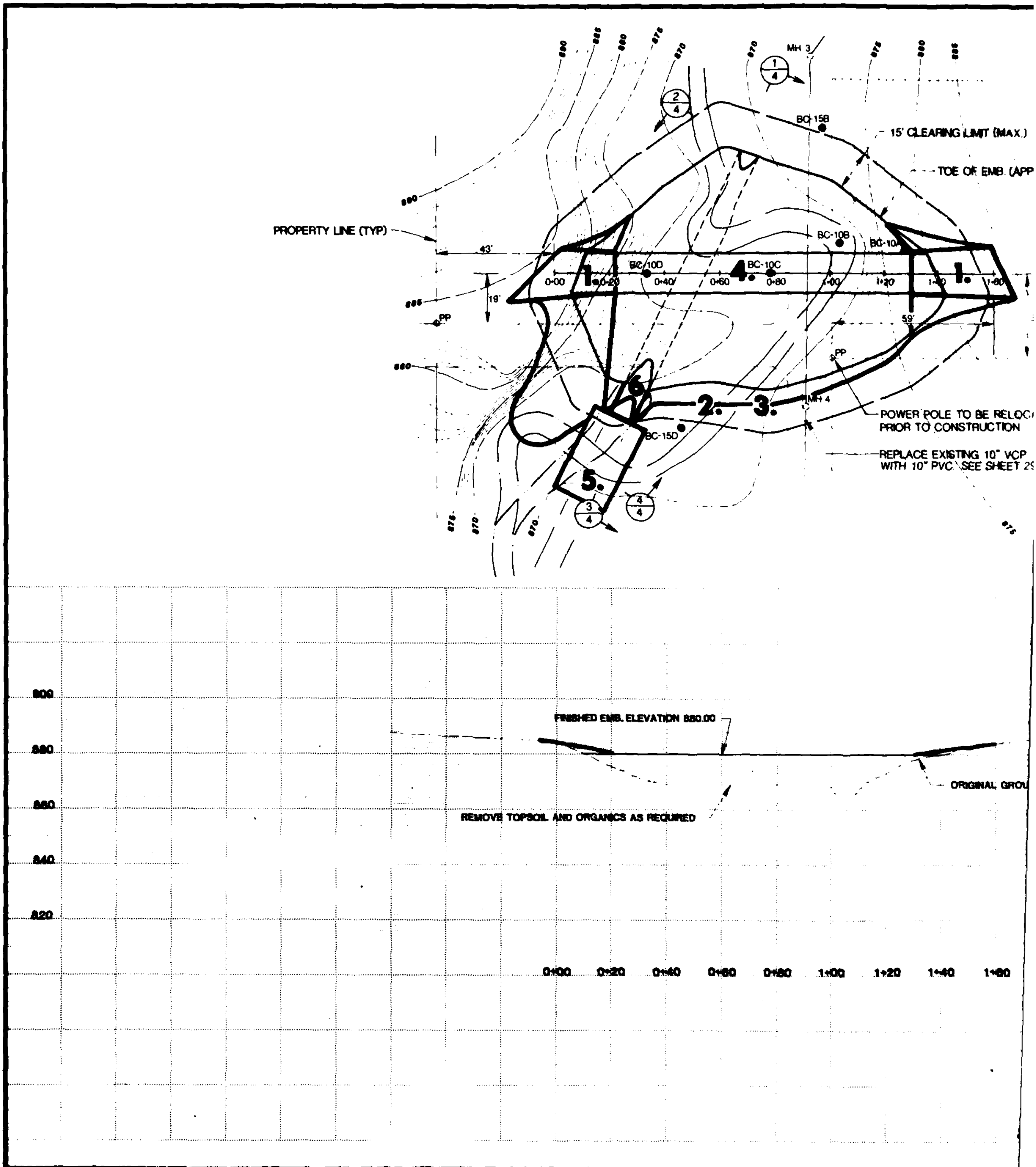
EDGEWOOD EMBANKMENT

6. The local design proposal for the Edgewood Embankment does not meet design standards required for Corps facilities and has not been indorsed as an acceptable design. However, in June 1982, the Corps agreed to reimburse local interests for the advance construction on the Edgewood embankment which can be incorporated into the final configuration of the Edgewood embankment. This was done with an explicit denial of liability for the performance of the locally constructed Edgewood embankment. It did acknowledge that materials in place upon Federal construction of the final configuration, assuming a failure had not occurred, would have a reimbursable value. Materials which cannot be used in the final embankment design will not be considered reimbursable and disposal of such materials will be considered a non-Federal expense. Some detailed design information on the Edgewood embankment can be found in Appendix A.

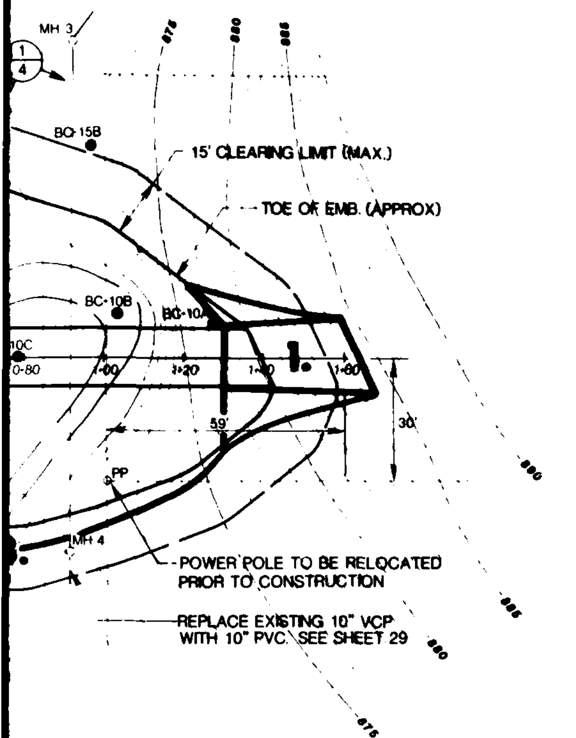
7. It is proposed that the Section 215 construction, or first phase work, be supplemented by Federal construction in a second phase, completing the design developed by the St. Paul District. Drawings showing the conceptual modifications to be made to the Section 215 work are shown on plates I-1 and I-2.

FEDERAL COST

8. Presently, a total of $434,342 is estimated to be reimbursable by the Federal government for engineering and construction on project features considered local responsibilities. From this amount, approximately $34,000 would be deducted for Federal review of the advance local work, including engineering, supervision and administration as stated in Article 4(b) of the Section 215 agreement.

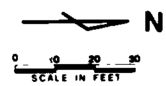


MH 3
BC-15B
15' CLEARING LIMIT (MAX.)
TOE OF EMB. (APP
PROPERTY LINE (TYP)
43'
19'
PP
BC-10B
BC-10A
BC/10D
BC-10C
0+00
0+20
0+40
0+60
0+80
1+00
1+20
1+40
1+60
59'
MH 4
BC-15D
POWER POLE TO BE RELOC
PRIOR TO CONSTRUCTION
REPLACE EXISTING 10" VCP
WITH 10" PVC. SEE SHEET 2
FINISHED EMB. ELEVATION 880.00
ORIGINAL GROU
REMOVE TOPSOIL AND ORGANICS AS REQUIRED
900
880
860
840
820



NOTES: 1) BACKFILL FOR 10" PVC BETWEEN MH 3 AND MH 4 SHALL MEET THE GRADATION AND COMPACTION REQUIREMENTS OF IMPERVIOUS CLAY

2) CONTRACTOR SHALL SAVE ALL TREES DESIGNATED BY THE ENGINEER WITHIN THE CLEARING LIMITS



PHASE II MODIFICATIONS

1. PROVIDE ABUTMENT PROTECTION

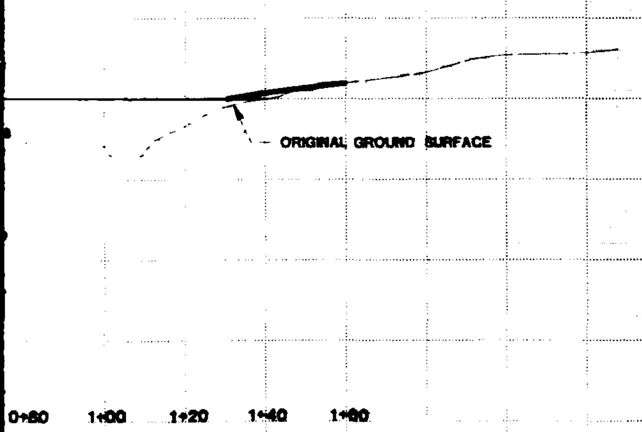
2. FLATTEN DOWNSTREAM SLOPES

3. KEY IN RIPRAP SLOPE

4. MODIFY EMBANKMENT CREST TO PROVIDE DESIRED HYDRAULIC DESIGN

5. PROVIDE ENERGY DISSIPATOR

6. EXTEND BOX CULVERT



CITY OF GOLDEN VALLEY
BASSETT CREEK FLOOD CONTROL

I HEREBY CERTIFY THAT THIS DRAWING OR PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA

DATE
REG NO

REVISIONS
DETAILS 1/18/81

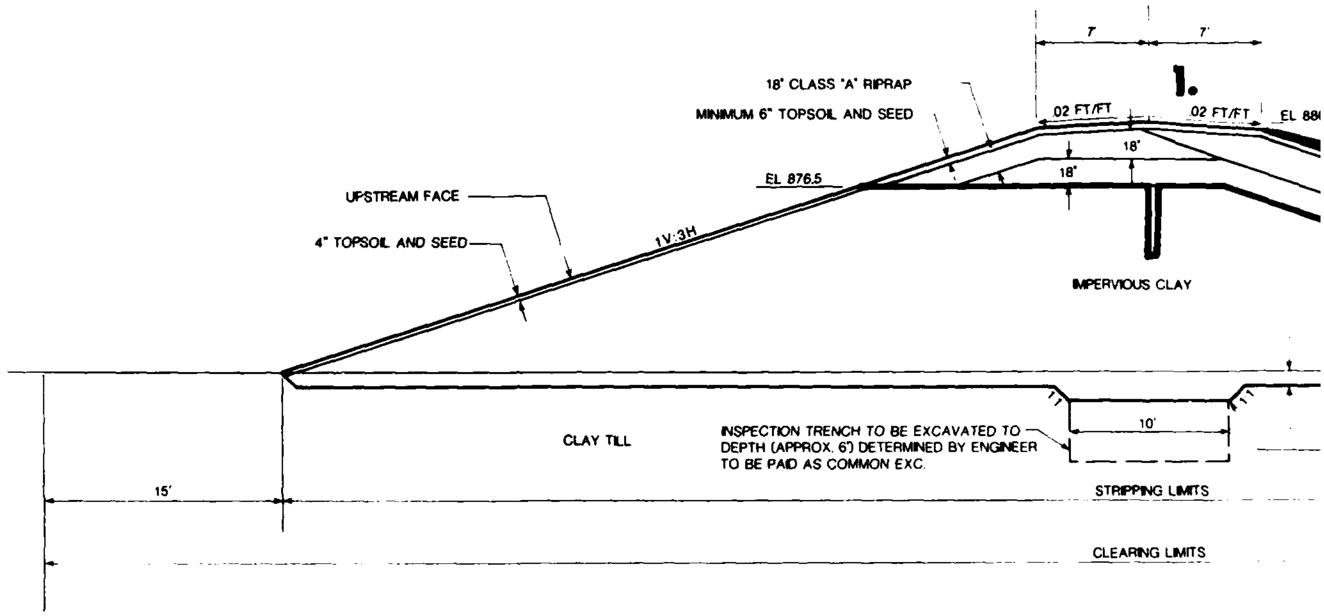
SCALE AS SHOWN
DWN BY
DATE 10/31/80
DWG NO

BARR ENGINEERING CO.
CONSULTING ENGINEERS
MINNEAPOLIS, MINNESOTA

EDGEWOOD EMBANKMENT
PLAN AND PROFILE

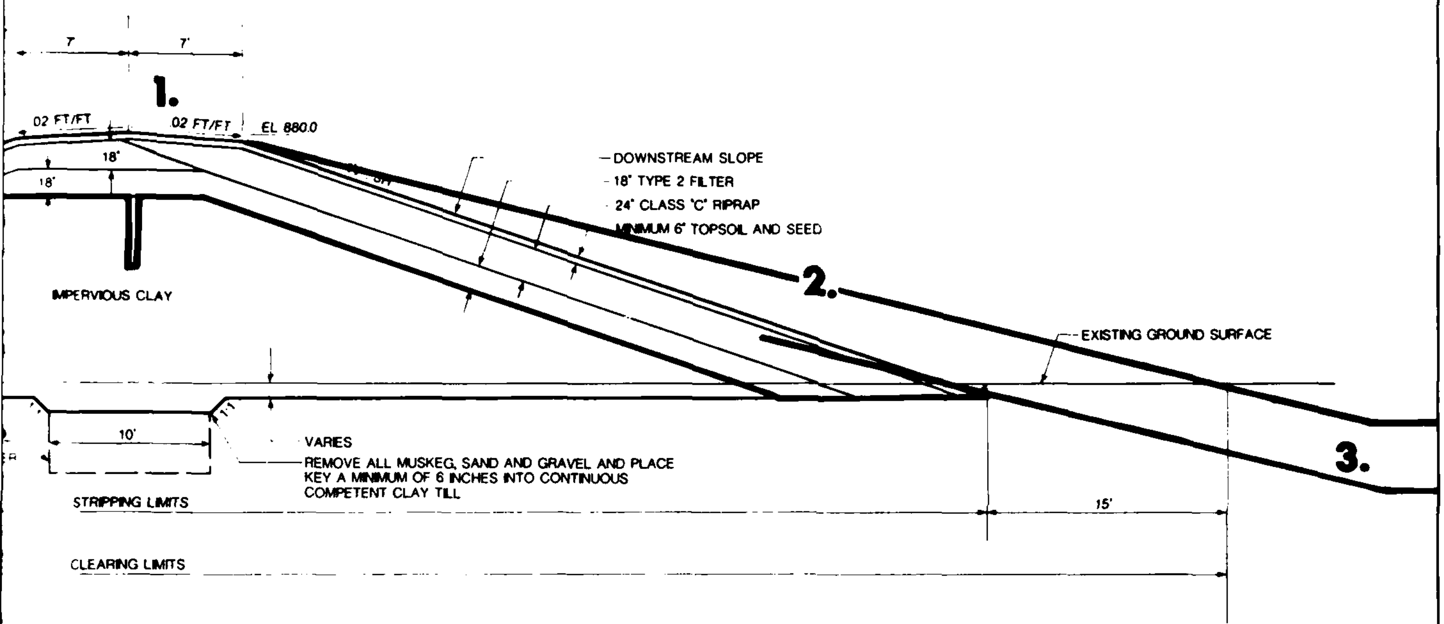
SHEET NO
OF
SHEETS

PLATE I-1



TYPICAL SECTION: EDGEWOOD EMBANKMENT

SCALE 1" 5'



EDGEWOOD EMBANKMENT

SCALE 1" 5'

PHASE II MODIFICATIONS

1. MODIFY CREST TO PROVIDE DESIRED HYDRAULIC DESIGN

2. FLATTEN SLOPES (REDESIGN RIPRAP)

3. KEY IN RIPRAP SLOPE

I HEREBY CERTIFY THAT THIS DRAWING OR PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA

DATE

REG NO

REVISIONS

SCALE AS SHOWN

DWN BY

DATE 10/31/80

DWG NO

CITY OF GOLDEN VALLEY
BASSETT CREEK FLOOD CONTROL

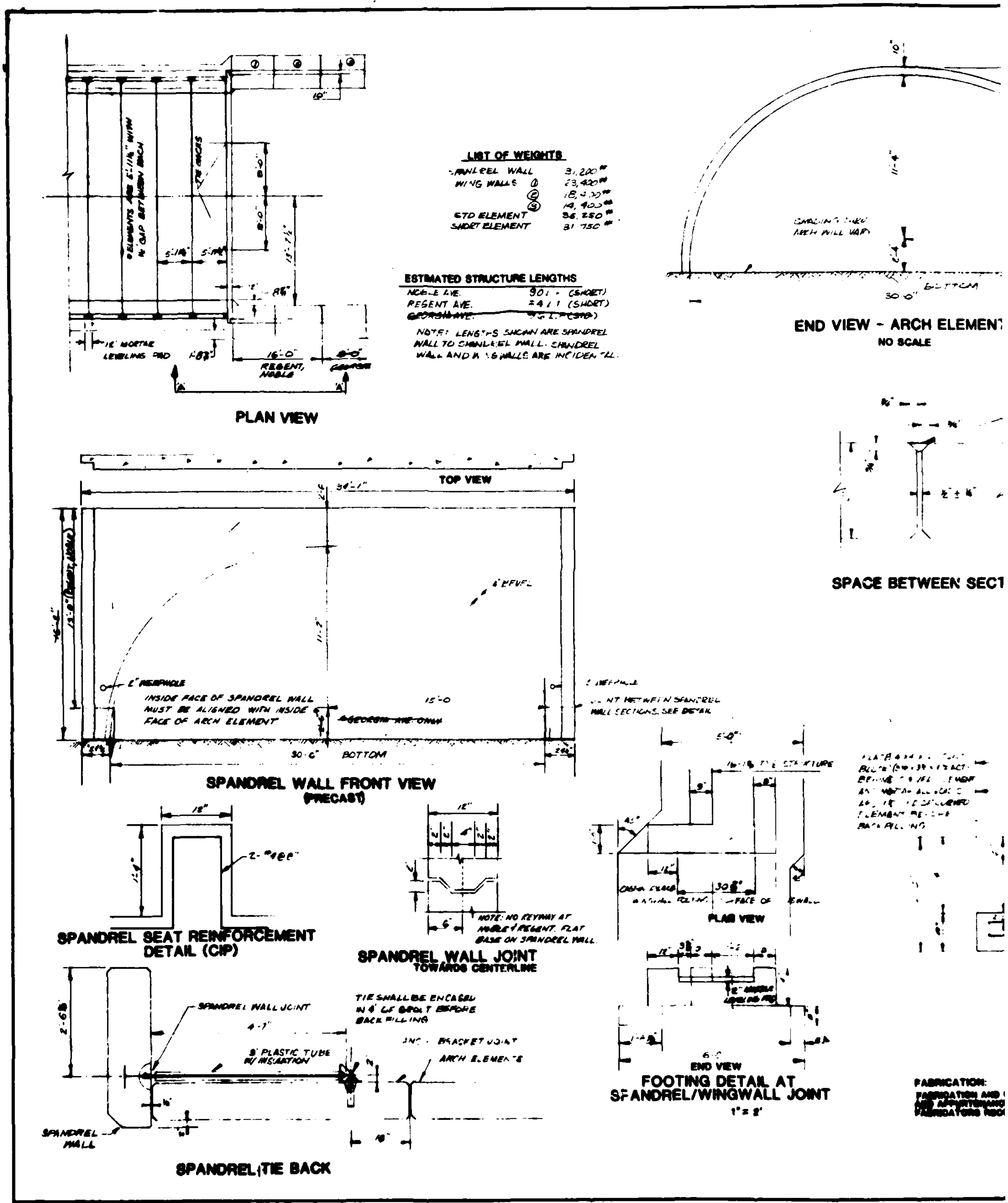
BARR ENGINEERING CO.
CONSULTING ENGINEERS
MINNEAPOLIS MINNESOTA

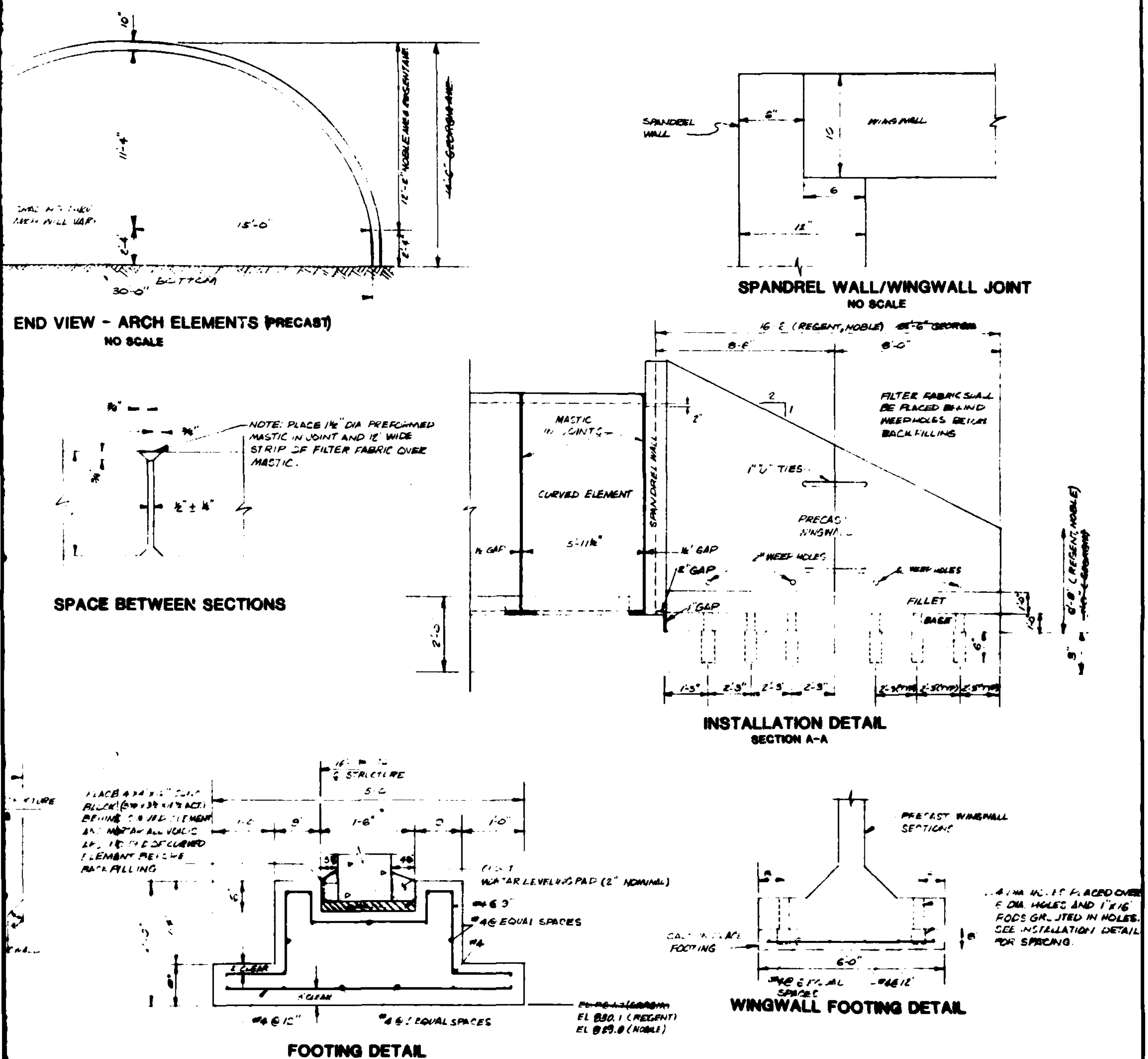
EDGEWOOD EMBANKMENT
TYPICAL SECTION

SHEET NO OF SHEETS

PLATE I-2

2


LIST OF WEIGHTS
WING WALLS
STD ELEMENT
SHORT ELEMENT
ESTIMATED STRUCTURE LENGTHS
REGENT AVE.
NOTE: LENGTHS SHOWN ARE SPANDREL WALL TO SPANDREL WALL.
PLAN VIEW
END VIEW - ARCH ELEMENT
NO SCALE
SPACE BETWEEN SECT
TOP VIEW
INSIDE FACE OF SPANDREL WALL MUST BE ALIGNED WITH INSIDE FACE OF ARCH ELEMENT
BOTTOM
SPANDREL WALL FRONT VIEW
(PRECAST)
SPANDREL SEAT REINFORCEMENT DETAIL (CIP)
SPANDREL WALL JOINT
TOWARDS CENTERLINE
NOTE: NO KEYWAY AT NOBLE & REGENT. FLAT BASE ON SPANDREL WALL.
PLAN VIEW
END VIEW
FOOTING DETAIL AT SPANDREL/WINGWALL JOINT
1" = 2'
SPANDREL WALL JOINT
TIE SHALL BE ENCASED IN 4' OF GROUT BEFORE BACK FILLING
3" PLASTIC TUBE W/ INSULATION
ARCH ELEMENTS
SPANDREL WALL
SPANDREL TIE BACK
FABRICATION:



JOINT

FABRICATION:
FABRICATION AND CONSTRUCTION OF BEBO STRUCTURES AND APPURTENANCES SHALL BE IN ACCORDANCE WITH FABRICATORS RECOMMENDATIONS.

I HEREBY CERTIFY THAT THIS ... PLAN WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED ... ENGINEER UNDER THE LAWS OF THE STATE OF ...	REVISIONS	SCALE:	CITY OF GOLDEN VALLEY BASSETT CREEK FLOOD CONTROL
DATE: ...-20-81 REG. NO. 6090	REV. 10/26/81	DWN. BY: JLS DATE: DWG. NO.	HANCOCK CONCRETE PRODUCTS CO., INC. (612) 835-4640
			ALTERNATE CROSSINGS NOBLE, REGENT, BEBO DETAILS

PLATE I-3

END

DATE
FILMED

11 83

DTIC